seismic safety element

Comprehensive General Plan City of Santa Monica

1

POLICY REPORT

KOEBIG & KOEBIG, INC. ENGINEERING · ARCHITECTURE · PLANNING ENVIRONMENTAL MANAGEMENT

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Physical, Ecological and Social Science Consultants

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December, 1975

Mr. J. W. Lunsford
Planning Department
City of Santa Monica
202 City Hall
1685 Main Street
Santa Monica, California

Dear Mr. Lunsford:

Forwarded herewith is the Seismic Safety Element for the General Plan. The element comprises two volumes; Volume 1 presents the policies and implementations to minimize seismic hazards in Santa Monica. Volume 2 includes the technical data and analyses to substantiate Volume 1. This study has been prepared with the intent of complying with current California State guidelines governing preparation of this General Plan Element.

Special thanks are extended to the staff of the Environmental Services Department, in particular, Valdis Pavlovskis, Joseph Eisenhut, and Russell Stewart of the Planning and Zoning Division, and William Rome of the Building and Safety Division, for their timely suggestions and assistance.

We appreciated the opportunity to prepare this challenging study, and look forward to providing future services to the City.

Respectfully submitted,

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POLICY REPORT

Seismic Safety Element
General Plan

CITY OF SANTA MONICA

Prepared by:
ENVICOM CORPORATION
and
KOEBIG, INC.

December, 1975

ERRATA POLICY REPORT

p. 7 line 9 "...magnitude 6.5 event..."

line 19 "...specifically address..."

p. 17 line 26 "Z = Seismicity..."

p. 55 line 1 "...Implementation..."

ACKNOWLEDGEMENTS

This study was prepared for the City of Santa Monica, California.

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I. INTRODUCTION

A. LEGISLATIVE AUTHORITY

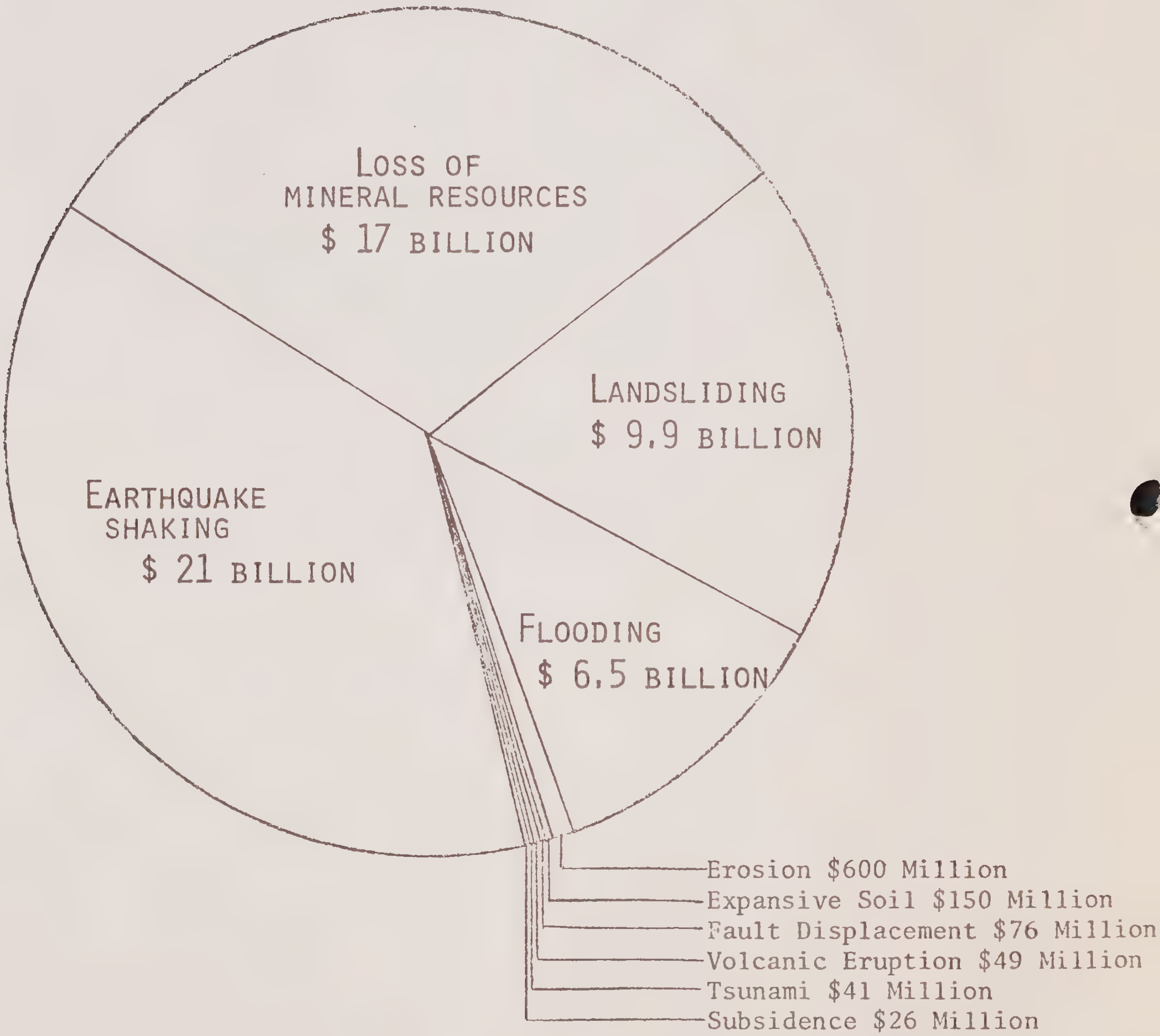
The California State Legislature, through the requirement of the Seismic Safety Element, has placed specific responsibilities on local government for identification and evaluation of earthquake hazards and formation of programs and regulations to reduce risk. Specific authority is derived from Government Code Section 65302 (f) which requires a Seismic Safety Element of all city and county general plans as follows:

> "A Seismic Safety Element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches.
>
> "The Seismic Safety Element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves (Section 65302(f)."

The effect of this section is to require cities and counties to take seismic hazards into account in their planning programs. The principal catalyst for this requirement was the February 9, 1971, San Fernando earthquake in which 64 people were killed and property damage exceeded one-half billion dollars. Conclusions from the 1973 Urban Geology Master Plan for California also give reason for considering geologic hazards in the planning process. Summary conclusions from this study estimate dollar losses due to geologic hazards in California between 1970 and 2000 will amount to more than $55 billion (Figure 1).

Figure I-1

GEOLOGIC HAZARDS IN CALIFORNIA
TO THE YEAR 2000:
A $55 BILLION PROBLEM



Source: Urban Geology, Master Plan for California, Bulletin 198, 1973.

B. PURPOSE AND APPROACH

The basic objectives of the Seismic Safety Element are to identify and evaluate earthquake hazards confronting cities and counties and to recommend policies that would reduce the adverse impact of those hazards if they are realized. Specifically, the Element evaluates both primary and secondary seismic hazards, including ground shaking, liquefaction and settlement potential, landsliding, and tsunami hazard. The intent of the recommended policies is to provide an opportunity to reduce the loss of life, property damage, and social and economic dislocations in the event of a major earthquake.

The purpose of this document is to serve as an official guide to the City Council and the Mayor, the Planning Commission and other governmental bodies, citizens, and private organizations concerned with earthquake hazards in the City of Santa Monica. The Seismic Safety Element is intended to establish uniformity of policy and direction within the City government to minimize the risk from seismic events and other natural hazards. The Element includes goals, policies, safety criteria, and maps as a basis for decision-making in public and private development matters. Such information is to be used in conjunction with other established City policies contained in the General Plan, and should play a major role in determining future land use.

The Seismic Safety Element has been prepared in two phases for the City of Santa Monica. The first phase involved a technical evaluation of primary and secondary seismic hazards and their probable effects on public facilities. The results of this evaluation were published in the <u>Draft Technical Report, Seismic Safety Element, City of Santa Monica.</u> The second

phase of the planning study dealt with the policy implications of the technical findings for the City. This Policy Report presents the conclusions and recommendations of this second phase, and completes the State requirements for the Seismic Safety Element for the City of Santa Monica.

This report is structured around four central parts: a summary discussion of natural hazards and risk, a technical evaluation of existing structural hazards, recommendations for hazard reduction, and the relationship of those recommendations to other elements of the General Plan. Both the evaluation of existing structures and the recommendations regarding seismic design criteria involve discussions of a technical nature. These discussions are vital to an understanding of the policies of the Seismic Safety Element and so are included in this report rather than the Technical Report. The approach of these sections is to rely on qualitative descriptions as much as possible for the lay reader, while presenting the important mathematical concepts for those with an engineering background. The heart of the Element is contained in the section entitled "Hazard Reduction." The general policies and technical recommendations in this section constitute the recommended seismic safety plan for the City of Santa Monica.

Throughout this report, reference is often made to the figures, tables, and maps presented in the Technical Report. It is, therefore, advisable to have a copy of the Technical Report on hand while reading this Policy Report.

II. EXISTING CONDITIONS

A. TYPES OF HAZARDS

1. Basic Concepts

There are several types of seismic hazards which can be grouped in a cause-and-effect classification that is the basis for the order of their consideration. Earthquakes originate as shock waves generated by movement along an active fault. The primary seismic hazards are ground shaking and the potential for ground rupture along the surface trace of the fault. Secondary seismic hazards result from the interaction of ground shaking with existing soil and bedrock conditions, and include liquefaction, settlement, landslides, tsunamis or "tidal waves", and seiches (oscillating waves in lakes and reservoirs).

The potentially-damaging natural events (hazards) discussed above may interact with man-made structures. If a structure is unable to accommodate the natural event, failure will occur. The potential for such failure is termed a structural hazard, and includes not only structures themselves, but also the potential for damage or injury that could occur as the result of movement of loose or inadequately restrained objects within, on, or adjacent to a structure.

A more in-depth introduction to earthquake terminology and concepts is presented in the Introduction of the Technical Report of the Seismic Safety Element, along with a Glossary of Terms in Appendix A of this report.

2. Summary Technical Conclusions

a. Geologic Conditions

The foundation of this Seismic Safety Element is the evaluation of primary and secondary seismic hazards in the City of Santa Monica. These evaluations form the basis for the recommended policies and are discussed in detail in the Technical Report. Major conclusions from the technical analysis are as follows:

1. The City of Santa Monica is located in a seismically active area.
2. The states of activity of the major faults affecting Santa Monica have been evaluated using available detailed mapping supplemented by local field examinations. Principal conclusions are:
   a) The San Andreas fault is active, and is expected to be the source of a magnitude 8.0-8.5 earthquake in the near future.
   b) The Newport-Inglewood fault is active, and can be expected to be the source of the following magnitude earthquakes at the specified recurrence intervals:

Recurrence Interval	Magnitude
100 years	5.2
150 years	5.6
300 years	6.5

   c) The Malibu Coast-Santa Monica fault zone traverses the City and is considered potentially active. The California Division of Mines and Geology is in the process of delineating Special Studies Zones along the traces of the fault as required by the Alquist-Priolo Special Studies Zones Act (SB 5).

3. The most significant seismic hazard in the City of Santa Monica is strong to severe ground shaking generated by movement along the Newport-Inglewood and San Andreas fault zones.

4. Surface rupture along the Malibu Coast-Santa Monica fault zone in the City is considered a hazard, but one that is more localized than the ground shaking hazard and that has a relatively low risk of occurrence.

5. The maximum ground accelerations in Santa Monica from the expected mangitude 6.5 event on the Newport-Inglewood fault zone will exceed the ground accelerations taken into account in the 1973 Uniform Building Code (0.133g) by three to four times. The expected magnitude 8.0-8.5 event on the San Andreas fault will produce maximum ground accelerations in the City of only about 150% of those taken into account in the 1973 U.B.C.

6. Liquefaction is considered a significant hazard in the part of the low-lying coastal area underlain by beach sand deposits as delineated on Plate I in the Technical Report. Soils engineering reports prepared for sites within the area of high liquefaction potential should speicifically address the problems of liquefaction and attendant settlement, and evaluate them using the ground shaking parameters presented in this report.

7. Significant settlement, other than that associated with liquefaction, can be expected at sites underlain by an apparent refuse disposal site bounded by Cloverfield, 26th, Broadway, and Colorado. Soils engineering investigations for developments in the vicinity should address this problem.

8. Landsliding is considered a significant hazard in the vicinity of the sea cliffs as shown on Plate I.

9. Hazardous tsunamis (seismic sea waves or "tidal waves") may occur along the coastal areas. Low-lying coastal and inland areas should be evacuated during a tsunami alert if the arrival is coincident with a flood tide.

10. The effects of seiching (oscillating waves in enclosed bodies of water) within storage tanks may be significant and should be evaluated by a qualified structural engineer.

b. Structural Conditions

The seismic hazards summarized above are of most concern to the City of Santa Monica in their effect on the structures and facilities in the City. Some of the largest earthquakes of record have occurred in unpopulated regions, and have received little notice except by seismologists. It is those large magnitude earthquakes which occur in heavily populated regions, such as the Los Angeles basin, that are the focus of seismic safety planning. The following conclusions are the result of a structural survey of the City of Santa Monica. They summarize the effects that a large magnitude earthquake is likely to have on the City.

1. Preliminary surveys by the City Building Department indicate that there are 250 to 300 unreinforced masonry structures in the City, including three movie theaters and one church. Most of the shops in the 1300 and 1400 blocks of the downtown Mall are constructed of unreinforced masonry. This type of construction is considered unsafe in the event of a major earthquake and likely to collapse on the building's occupants.

2. One-story, single-family wood frame residences are the most common residential building in the City and are considered to have a high level of seismic resistance. Apartment buildings are mostly two or three story wood frame buildings. There are few unreinforced masonry apartment buildings which do not meet present code requirements. Most of the new apartment buildings are reinforced concrete or structural steel high rise structures. Condominiums are a new type of residential structure in Santa Monica and are primarily two-story frame construction or high rise, reinforced concrete or steel buildings.
3. A number of hotels have been built in Santa Monica over the years, and the older ones are constructed of unreinforced masonry.
4. Small commercial structures in the City are generally one-story, wood frame, reinforced or unreinforced masonry buildings.
5. Most office buildings in the City are modern high rise structures. There are few unreinforced masonry structures used as offices.
6. Most industrial buildings in Santa Monica are located in the eastern area of the City and are recent one and two story structures.
7. Public assembly buildings in the City comprise the City Hall, the civic auditorium, a number of movie theaters, churches, schools, night clubs, and a few convention and reception halls in the hotels. Three movie theaters and one church have been identified as unreinforced masonry structures.

8. All public buildings appear to comply with existing code requirements. The City's central communication facility is located in a Hazard Management Zone near the south branch of the Malibu Coast-Santa Monica fault and should be further evaluated. Loss of the facility is possible in the event of ground rupture along the fault.

9. Existing hospitals and convalescent hospitals have been constructed under provisions of the UBC. Schools in the City were constructed under the authority of the Division of Architecture and Construction of the California Department of Public Works which enforces earthquake safety requirements more restrictive than the Uniform Building Code.

10. Surface movement along the north branch of the Malibu Coast-Santa Monica fault zone may involve tilting of the Mount Olivette reservoir. Waves generated by this tilting may overtop the reservoir and create local flooding.

11. Of the utility systems serving the City, the water system would experience the most serious impediment to normal operations as a result of surface displacement along either branch of the Malibu Coast-Santa Monica fault zone. Damage to the Arcadia Water Softening Plant could mean that potable water would be scarce in the aftermath of such an event.

    Because the City obtains water from several sources and introduces or can introduce water to the system at various points, maintenance of necessary fire flow should be possible.

12. The sanitary systems will suffer severed or broken collector lines in a major movement on the south branch of the Malibu Coast-Santa Monica fault and up to 40% of the collective system

could be inoperative in this event. By-passing or repair of damaged trunk sewer lines should permit service to the northwesterly portions of the City to be reinstituted within a nominal period.

13. Several public utilities and/or structures lie within the areas of landslide and liquefaction/settlement potential.

B. RISK

Given that certain geologic and structural hazards exist in Santa Monica, it is necessary to decide whether the risks these hazards present are acceptable or whether action is necessary to reduce the level of risk. The Council on Intergovernmental Relations (CIR) defines "Risk" from natural and man-made hazards in three categories:

1. Acceptable Risk: The level of risk below which no specific action by government is deemed to be necessary.
2. Unacceptable Risk: The level of risk above which specific action by government is deemed to be necessary to protect life and property.
3. Avoidable Risk: A risk which need not be taken because individual or public goals can be achieved at the same, or less, total "cost" by other means without taking the risk.

To determine levels of acceptable risk is to provide an answer to the question "How safe is safe enough? No environment is perfectly hazard-free. Natural and man-made hazards of some kind are always present, especially in urban environments. However, some hazards cause only minimal loss or occur so rarely that they need not be planned for at the community level. On the other hand, some events occur often enough, are large enough, and have the potential for major disruption of the community such that a community-wide response to the risk is called for. Deciding the level of response to natural hazards such as earthquakes is a public process which involves making a judgment, either explicit or implicit, about acceptable risk. Scientific expertise can determine the magnitude of the hazard and estimate the probable effects, but it cannot decide for the public how much risk to assume (or not assume by planning for loss-reduction).

In the City of Santa Monica, the decisions regarding acceptable risk from earthquakes were made at a joint public meeting of the City Council and Planning Commission on May 21, 1975 at which several citizens' advisory committees and task forces participated.

The central concept used in determining levels of acceptable risk is the definition of natural events in terms of magnitude and frequency. The magnitude of an event refers to its size. Examples are the height of flood waters, the rating of an earthquake on the Richter scale, or the number of acres burned in a wildland fire. The frequency of an event refers to the number of times it occurs during a certain period of time. The relationship between magnitude and frequency is inverse. That is, the less often an event occurs, the greater is its size and potential impact. For example, rainstorms occur annually in the City of Santa Monica, but most often they are of low magnitude and do not seriously threaten the City. However, on infrequent occasions a storm of large magnitude passes over the City and results in potentially dangerous drainage problems. A way of summarizing this idea with respect to an earthquake is that the longer it waits, the bigger it will be.*

The magnitude-frequency concept is involved in the decisions regarding acceptable risk in that the community must judge what magnitude event should be planned for. That judgment is based on the frequency or recurrence interval of the hazardous event. A description of the magnitude and other characteristics of the event are developed through a technical analysis. This information allows planners and engineers

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*There is one important difference between flooding and earthquakes, however. Flooding is the result of a random combination of meteorological events, whereas current geologic theory indicates that the buildup of strain along a particular fault system is nearly constant and the periodic release of that strain in the form of an earthquake is apt to be regular.

to develop loss-reduction measures and to design structures to provide protection up to the level of acceptable risk. In this sense, the magnitude earthquake or flood used in defining acceptable risk may be thought of as a "design earthquake" or "design flood."

The determination of acceptable risk from hazardous events also involves differentiating among man-made structures according to their potential effect on the loss of life and their importance in terms of emergency response and continued community functioning. In the hours immediately following the 1971 San Fernando earthquake in Southern California, emergency services were impaired by damage to police and fire stations, communication networks and utility lines. A number of major hospitals in the area were seriously damaged and were unable to continue functioning at the time they were needed most. These facilities and others are vital to the community's ability to respond to a major disaster and to minimize loss of life and property. The experience in San Fernando emphasized the need to provide these "most critical" and "critical facilities" a higher level of protection from earthquakes than non-critical structures. As a minimum, all structures which could have an effect on the loss of life should be designed to remain standing in the event of a major earthquake even if rendered useless. "Most critical" facilities, on the other hand, should not only remain standing, but should be able to operate at peak efficiency in the event of a disaster.

Designing a building to this higher level of seismic safety entails not only a stronger structure, but also greater attention to non-structural items such as elevators, lighting and storage facilities.

Deciding which types of facilities are to be considered critical and non-critical is part of the public decision on acceptable risk. The following Tables II-1 and II-2 present the recommended categorization of buildings and design earthquakes for those categories.

TABLE II-1

TAXONOMY OF FACILITY TYPE

Category	Facility/Activity
Most Critical	Hospitals, Civil Defense Communications, Water Supply Facilities, Fire and Police Facilities, Telephone Communication Facilities, Electrical Substations, Evacuation Route Facilities, City Hall
Critical	Schools, Theaters, Auditoriums, Clinics, Drug Stores, Main Food Markets, Food and Drug Warehouses, Utility Systems, Communication Systems, Bridges, Pipelines, Major public areas including shopping centers, parks, convention and conference facilities, all structures over 5 stories
Non-Critical	Structures under 5 stories, including residential, commercial, industrial, office, and similar uses

TABLE II-2

ACCEPTABLE RISK LEVELS FOR SEISMIC SAFETY

FACILITY/ACTIVITY	DESIGN LEVEL	DESIGN EVENTS
Most Critical	Continued Function	6.5 Richter Magnitude, Newport-Inglewood fault and 8.5 Richter Magnitude, San Andreas fault
Critical	Continued Function	5.6 Richter Magnitude, Newport-Inglewood fault and 8.5 Richter Magnitude San Andreas fault
	Non-Collapse	6.5 Richter Magnitude Newport-Inglewood fault
Non-Critical	Continued Function	5.2 Richter Magnitude Newport-Inglewood fault
	Non-Collapse	8.5 Richter Magnitude, San Andreas fault

C. TECHNICAL EVALUATION OF THE EXISTING STRUCTURES

1. Buildings Codes

In the past, the City of Santa Monica has adopted Uniform Building Codes as a standard city building regulation.

Until 1927, Uniform Building Codes had no special requirements to assure earthquake resistance in buildings. Earthquake and wind forces were considered together as a 30 pound per square foot load on the outer surface of the buildings. In 1927, the Uniform Building Code added a section covering earthquake resistance requirements employing the simple Newtonian concept of lateral earthquake forces proportional to masses.

After the March, 1933, Long Beach earthquake, the State Legislature adopted the Riley Act requiring all buildings except certain type of dwellings and farm buildings, to be designed for a lateral force 2% of the total vertical design load. In 1953, this requirement was revised to require 3% for buildings less than 40 feet in height, and 2% for those over 40 feet in height.

Until 1961, Uniform building codes took into account only two factors in the development of a base shear. In formula form, these were:

$$V = CW$$

where:

V = base shear,
C = resonance effect,
W = dead load plus some live load.

1961 Uniform Building Code added two more factors.

The new factors were:

Z = Seismisity (or zone) coefficient,

K = Ductility factor and,

the formula became, $V = ZKCW$

The present 1973 Uniform Building Code uses the same formula. However, various code requirements concerning earthquake safety and methods of determining the coefficients in base shear formula have considerably improved since 1961.

The February, 1971, San Fernando Earthquake provided a well documented test and case study for recent building codes. This 6.6 Richter Scale magnitude earthquake caused 58 deaths and a loss of 500 million dollars. Loss caused by this earthquake probably represents an acceptable risk. However, 6.6 Richter Scale is not the maximum earthquake expected in the region, and because of the number of other factors, the same magnitude earthquake may cause more damage in some other regions.

Focusing on these factors and with the lessons learned from the San Fernando earthquake, the Uniform Building Code is being revised. The base shear formula in the 1976 Uniform Building Code will be:

$$V = ZIKCSW$$

The new factors included are:

I = Structural importance factor, and

S = Site-structure resonance factor.

As in previous Uniform Building Codes, the new code is not the ultimate design criteria for all areas and all buildings. The seismic design code in each community should be based on an acceptable risk factor determined by the community, should be adjusted to the geological and seismological characteristics of the area, and should be related to the architectural and building type traditions of the region. Table II-3 compares earthquake design codes of different countries with past, present and future codes in the USA. Code differences do not necessarily indicate weakness or conservatism in any code. They are merely the results of different community considerations and regional requirements.

TABLE II-3

SEISMIC CODE COMPARISONS

Formula Used In The Development

of Base Shear

Where: V = ZLIKCRSFW

V = base shear,
Z = seismicity coefficient,
L = structural life factor,
I = structural importance factor,
  (a) cost
  (b) occupancy
  (c) function
K = ductility factor,
C = resonance effect,
R = mode participation factor,
S = soils or site factor,
F = foundation design factor,
W = dead load plus some live load

CODE	FORMULA	NO. OF FACTORS
UBC OF USA Before 1961	V = CW	2
1961 to 1973	V = ZKCW	4
1976	V = ZIKCSW	6
CANADA	V = ZIKCSW	6
CHILE	V = ZCSFW	5
FRANCE	V = ZICSFW	6
JAPAN	V = ZKRSW	5
MEXICO	V = ZIKCSW	6
RUMANIA	V = ZIKCRSW	7
RUSSIA	V = ZCRSW	5
TURKEY	V = ZKRSW	5

2. Existing Structures

Generally, structure types are closely related with occupancies and will be described under the occupancy titles in the following paragraphs.

a. Residential Buildings

Residential buildings have three different occupancy types, each with unique structural characteristics.

1. One story single family houses are wood frame buildings and they are the most common residential building in the city.
2. Apartment buildings are mostly two or three story wood frame buildings. There are few unreinforced masonry apartment buildings which do not meet present code requirements. Most of the new apartment buildings are reinforced concrete or structural steel, high rise structures.
3. Condominiums are a new type of residential structure in the City. Most of the condominiums are two and three story frame buildings built in accord with 70 or 73 UBC or high-rise, reinforced concrete or steel buildings.

b. Hotels

A number of hotels in Santa Monica have been built over the years in the City. The older ones are unreinforced masonry structures.
There are few wood frame and reinforced masonry hotel buildings. New hotels mostly are structural steel or reinforced concrete high-rise structures.

c. Small Businesses

Unlike many Southern California cities, Santa Monica's downtown is the primary retail center. Consequently, a high number of small businesses, mostly retail outlets, are located in the City. These small businesses generally

operate in one story, wood frame, reinforced or unreinforced masonry building. Many modern looking shops at the Santa Monica Mall are unreinforced masonry buildings.

d. Office Buildings

Most of the office buildings are modern high rise structures. There are few unreinforced masonry structures in use as office buildings.

e. Industrial Buildings

There is some light industry at the east side of the city. Most of the industrial buildings are one and two story recently built structures.

f. Public Assembly Places

There is the City Hall, a civic auditorium, a number of movie theaters, schools, churches, night clubs, and a few convention reception halls in the hotels. Three of the movie theaters and one church are identified as unreinforced masonry buildings.

g. Schools and Hospitals

After the March, 1933, Long Beach earthquake, the State Legislature adopted the Field Act and assigned to the Division of Architecture of the State Department of Public Works the authority and responsibility under the police power of the State to review and approve or reject plans and specifications and to supervise the construction of all public school buildings. Appendix A of the Rules and Regulations adopted by the Division of Architecture originally required masonry buildings without frames to be designed for a lateral force of 10% of dead load plus a portion of live load. Other buildings were to be designed for 2% to 5%. The lower coefficients were related to higher allowable foundation loads. In the following years, these requirements were revised several times.

Today all schools and all hospitals and convalescent hospitals in the City were constructed in accordance with UBC requirements. All hospital buildings as well in California are constructed under the strict control of Office of Architecture and Construction to the requirements of the State Administrative Code Title 24, which has more restrictive earthquake safety requirements than Uniform Building Code.

h. Public Buildings

All public buildings appear to be complying with the post-1933 code requirements except the Ocean Park Library which does not comply.

D. HAZARD DELINEATION

1. Buildings

In mathematical terminology, earthquake hazard equation of a structure has three parameters, relating to each other as:

$$f\ (t) = f\ (e,s)$$

where:

t = type of occupancy,

e = magnitude of earthquake forces, and

s = type of structure.

a. Type of Occupancy

The type of occupancy determines the level of acceptable hazard, i.e., the acceptable risk of failure for a building. The occupancy factor is composed of three components: number of occupants, function of the occupancy, and economic value.

- The number of occupants is important in determining an acceptable risk level. Buildings occupied by two persons, 200 persons, or 2000 persons cannot be classified in the same risk levels. Basically, where more lives are involved, more protection is required.
- The function of the occupancy, particularly when the function is vital to the safety and normal functioning of the community has to be considered in determination of an acceptable risk level of a building. Collapse of a warehouse may be acceptable to a community, but the police or fire department should continue to function with the minimum of constraints after an earthquake.
- The economic value of a structure is important to the community as well as to its owner. Its loss will have an economic and social impact in the community in proportion to its economic value.

b. Magnitude of Earthquake Forces

The magnitude of an earthquake force on the building is related to magnitude of the earthquake, geological characteristics of the region, distance to the earthquake epicenter, type of soils between the site and the epicenter and the type of soil below the site. These factors in relation to Santa Monica are discussed in the Technical Report. We can do very little to change these factors except to classify them and assign relative values and then to develop appropriate building design criteria.

c. Type of Structure

Behavior of a structure during an earthquake is closely related to the construction type of the building. Different construction materials have different ductility and strength values; consequently, they react to the earthquake forces differently.

Shape of a building and geometry of the earthquake resisting frames have considerable effect on the amount of damage suffered by a building during an earthquake. These two characteristics determine the period of the structure, which is the main factor in determining the oscillation level of the structure.

Typical behavior is as follows:

- Wood frame buildings behave in a ductile manner during earthquakes. All elements of small one story wood frame buildings stay together even in the event of ground rupture; such buildings are practically uncollapsible. Large wood frame buildings of two or more stories may be badly damaged during an earthquake, but usually they do not totally collapse. However, wood frame buildings are fire prone. In past big earthquakes, most wood frame buildings have survived the earthquake, but have then been destroyed by the post-earthquake fires.

- Unreinforced masonry structures do not have much earthquake resistance. They are brittle, and in small earthquakes they crack; in stronger quakes, they collapse.
- Reinforced masonry buildings, when properly designed and constructed, can survive design earthquakes. However, they are brittle, and in strong quakes they crack or collapse.
- Behavior of reinforced concrete buildings during earthquakes is largely dependent on the design of the structure. Shear wall buildings behave as reinforced masonry structures. Structures with movement resisting frames designed to the ductility requirement behave ductilly even if they are damaged during an earthquake; generally, they do not totally collapse.
- Structural steel frame buildings are the most ductile structures of all the types mentioned above. During an earthquake, they may be damaged, but, unless ground rupture occurs, they do not totally collapse. Braced structural steel buildings are less ductile, and if they lose the bracings, they may collapse.

2. Unreinforced Masonry Buildings

a. Technical Aspects

Unreinforced masonry buildings are structures which have load carrying walls built without reinforcing steel. The Riley Act, adopted in 1933 by the California State Legislature, has effectively prohibited the construction of this type of building.

A force on a structural element creates basically three types of stresses: tension, compressions and shear. Masonry can resist compression stress.

Shear resistance value of masonry is reliable only if it has continuous holes or spaces in both vertical and horizontal directions, filled with grout. The tension resistance of masonry is not reliable, and, for that reason, it must be reinforced with steel bars.

Unreinforced masonry walls, with their compression capacity, function perfectly well under vertical loading in static conditions. During an earthquake, unreinforced masonry walls have to resist the horizontal forces which generate compression, shear and bending related tension stresses. Since they are not reinforced by steel bars, they cannot resist the tension stresses. They do not have continuous holes or spaces filled with grout, and, consequently, their shear resistance is not reliable. Furthermore, most unreinforced masonry buildings do not have effective floor or roof diaphragms, which are necessary structural elements for transferring the roof or floor loads to the shear walls. In some cases, there are reinforced concrete or unconventional wood diaphragms with some shear carrying capacity, but these diaphragms are not connected to the walls with sufficient, if any, connecters to transfer the shear. Another function of roof and floor diaphragms is to provide support for the walls at the various levels. Absence of the wall diaphragm connections leaves walls unsupported at roof or floor levels.

In summary, earthquake resistance of unreinforced masonry buildings is about nil. Past earthquake experiences in Southern California, as well as earthquakes elsewhere in the world, have shown that unreinforced masonry buildings collapse suddenly during earthquakes. In most past California earthquakes, casualties resulted from the collapse of unreinforced masonry buildings. In the February, 1971, San Fernando earthquake, 58 people died;

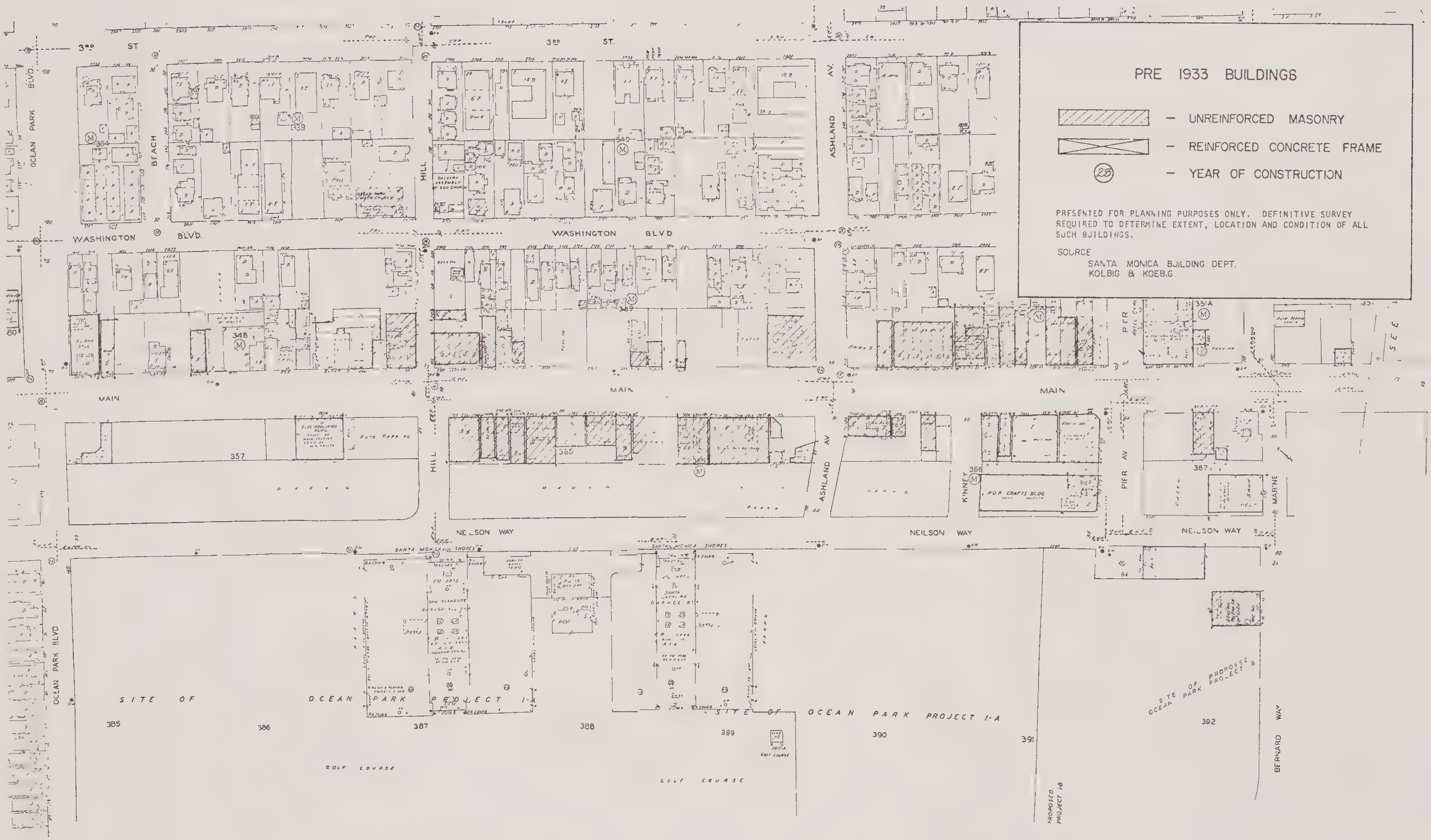
forty nine, or 85%, lost their lives under collapsed unreinforced masonry buildings.

Preliminary surveys made by the Building Department, indicate that there are 250 to 300 unreinforced masonry structures throughout the city of various sizes, heights, and occupancies. There are three unreinforced masonry movie theaters and a church among these structures. Their collapse while occupied would result in the deaths of hundreds of people. Most of the modern looking shops in the 1300 and 1400 blocks of the Mall area are unreinforced mansonry structures. This is the crowded, public area of the City. Collapse of the unreinforced masonry buildings in these blocks would result in an unprecedented diaster for the city.

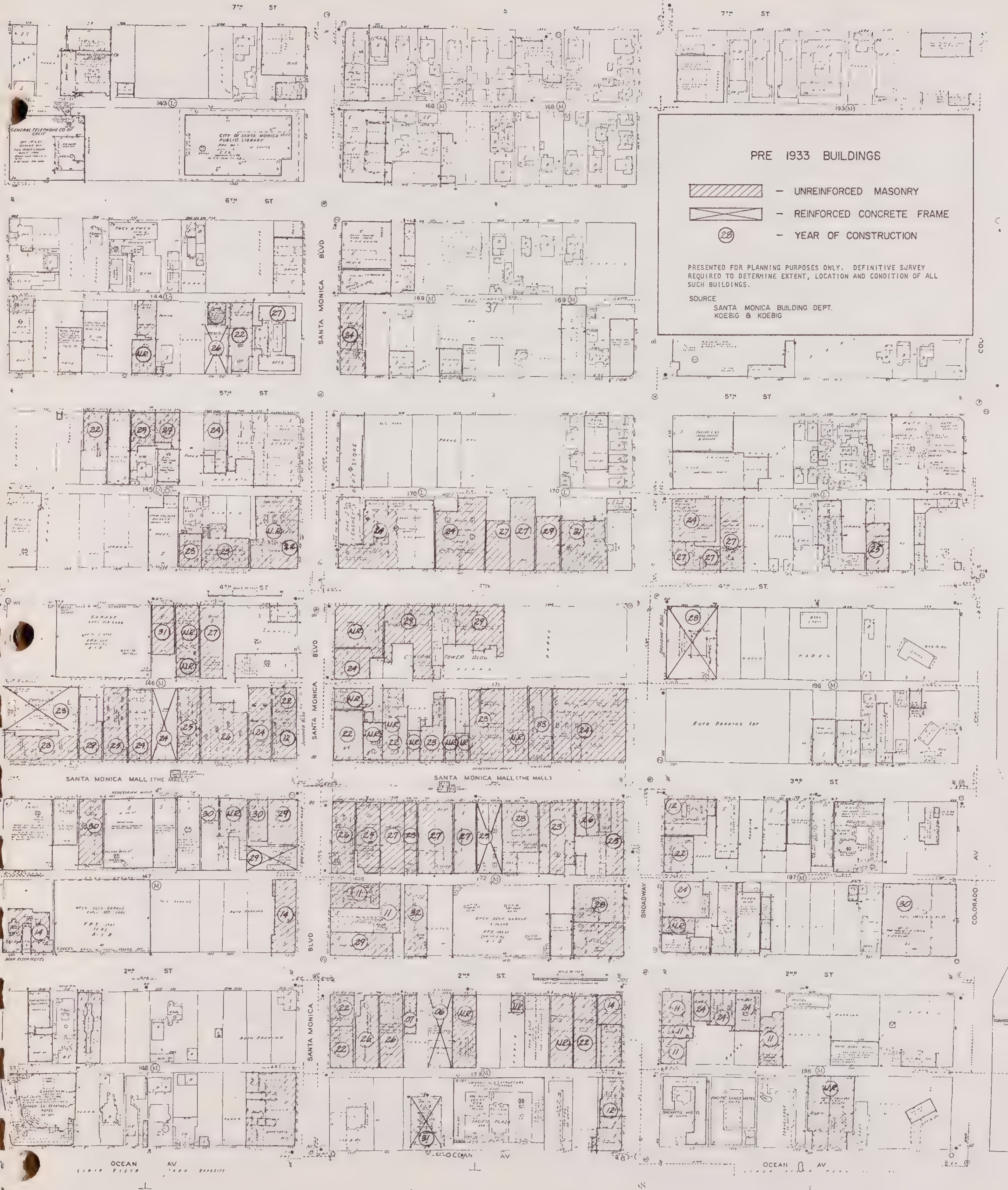
There are a number of unreinforced masonry hotels and apartment buildings. Most of the residents of these places are retired people with varying degrees of disability. These buildings are unusually crowded, and most of the residents spend most of their time in the buildings. These structures may collapse during an earthquake of any nominal intensity.

In the past, a number of government agencies and a number of professional groups have investigated the problem of unreinforced masonry structures. Technical findings of all of these investigations can be summarized simply as: "Unreinforced Masonry Structures are unsafe and they present an unacceptable level of risk to the community." However, economic and social aspects of the problems are complex.

Santa Monica's "Dangerous and Substandard Buildings" law was adopted in 1961.



PRE 1933 BUILDINGS
- UNREINFORCED MASONRY
- REINFORCED CONCRETE FRAME
28 - YEAR OF CONSTRUCTION
PRESENTED FOR PLANNING PURPOSES ONLY. DEFINITIVE SURVEY REQUIRED TO DETERMINE EXTENT, LOCATION AND CONDITION OF ALL SUCH BUILDINGS.
SOURCE
SANTA MONICA BUILDING DEPT.
KOLBIG & KOEBIG
3RD ST
3RD ST.
OCEAN PARK BLVD
BEACH
HILL
ASHLAND AV.
WASHINGTON BLVD.
WASHINGTON BLVD
MAIN
PIER AV
KINNEY
MARINE
NEILSON WAY
POP CRAFTS BLDG
SANTA MONICA SHORES
SITE OF OCEAN PARK PROJECT 1-A
SITE OF PROPOSED OCEAN PARK PROJECT 6
PROPOSED PROJECT 1B
BERNARD WAY
GOLF COURSE
357
364
339
340
348
349
351A
365
366
367
385
386
387
388
389
390
391
392



PRE 1933 BUILDINGS
– UNREINFORCED MASONRY
– REINFORCED CONCRETE FRAME
– YEAR OF CONSTRUCTION
PRESENTED FOR PLANNING PURPOSES ONLY. DEFINITIVE SURVEY REQUIRED TO DETERMINE EXTENT, LOCATION AND CONDITION OF ALL SUCH BUILDINGS.
SOURCE
SANTA MONICA BUILDING DEPT.
KOEBIG & KOEBIG
7TH ST
6TH ST
5TH ST
4TH ST
3RD ST
2ND ST
OCEAN AV
SANTA MONICA BLVD
BROADWAY
COLORADO AV
SANTA MONICA MALL (THE MALL)
CITY OF SANTA MONICA PUBLIC LIBRARY
GENERAL TELEPHONE CO OF CALIF
CENTRAL TOWER BLDG
OPEN DECK GARAGE
AUTO PARKING
AUTO PARKING LOT
PACIFIC PLAZA
PACIFIC SANDS MOTEL
MIRA VISTA HOTEL
DEPT STORE
PEDESTRIAN WALK
37

It was copied intact from an earlier Los Angeles ordinance that served as a model and is now published as part of the Uniform Building Code series. These ordinances are typical nuisance abatement ordinances and empower the Building Official to initiate condemnation proceedings when a building meets one or more of the defined conditions. Although this ordinance was adopted in 1961, it has only been rarely invoked in very apparent and severe nuisance cases. It has never been applied on the grounds of seismic hazard alone since under its terms the specified remedies (repair or demolition) must be commenced within 60 days after final determination of condition.

In the past, Building Department policy with respect to these structures has been to allow existing occupancies to continue undisturbed, while prohibiting occupancy changes that would require higher life safety classification under the present code. Enforcement of this simple public safety policy is often a difficult problem for the building department due to the economic consequences which the building owners would suffer.

Presently, in the City of Santa Monica, there is no program for repair or condemnation of unreinforced masonry structures, nor is there a program designed to provide warning of the hazard to the people entering, residing or leasing these unsafe structures.

b. Economic and Social and Political Implications

Any proposal to require the upgrading, modification or elimination of a structure affects the owners of the structures in a very direct economic way. Usually the entire cost of building improvement must be borne by the owner. The cost of improvements must, in turn, be passed on to the users of such facilities.

Old buildings in particular may house marginal businesses where a substantial rent increase may mean an operation is no longer profitable. In the case of residential buildings, social problems often result when low and fixed income persons are displaced, either as a result of the building being torn down or as a result of increased rents necessitated by building rehabilition. No easy solution exists to the problem of the social and economic impacts which result from a City's determination that, in the interest of public safety, all buildings shall conform to minimum seismic standards. The problem is particularly acute when the building in question is of unreinforced masonry construction, because usually the cost of the structural improvements required to make such buildings conform to current seismic standards necessitates an investment which is greater that the value of the building warrants.

For the community of Santa Monica, the problem of unreinforced masonry construction has two facets. First, the buildings represent a real hazard to the general public. A majority of the buildings are located in the "downtown" area of the City and house retail stores with intensive public use. Many also front on the "Mall" and therefore constitute a hazard for persons in this popular public open space as well as for those within the buildings. A major quake in the daytime or early evening hours would undoubtedly result in a substantial loss of life. Second, the retail activities which operate in such buildings contribute directly to the City's revenues through the generation of sales taxes and through property taxes. Destruction of these buildings by a major quake would probably cause a substantial loss of tax revenue to the City. Even gradual elimination of these buildings through a City code enforcement program could have a serious economic impact on revenues, since retail shopping areas require a "mix" of uses as well as certain anchor uses, such as department stores, to function effectively.

Gradual replacement of unreinforced masonry buildings in the downtown area may be possible, but a very carefully devised program would be required to minimize the economic impact on City revenues.

Finally, it should be noted that programs which require major building upgrading or reconstruction may be very unpopular, even in the face of overwhelming evidence that the buildings are unsafe. But a program which offers some options for the property owner may be more palatable and will enable the City to ensure that the public is reasonably protected in the event of a moderate or greater magnitude earthquake.

3. Utilities and Public Facilities

Damage to utility systems resulting from an earthquake is of two primary types. First, buildings and structures housing components of the system may be damaged as a result of earth shaking, along with equipment contained within the buildings which is essential to the functioning of the system. Second, in the event of ground rupture or liquefaction, lines may be damaged and broken. Generally, the problem of damage to utility system buildings, electrical substations, etc., is of greater concern, since a loss of service through all or part of the system may occur. Repair may involve considerable time and effort. Broken lines, however, can be capped, repaired or bypassed without serious impact on the total system.

Public facilities, particularly those important in the aftermath of an earthquake, should be located outside known hazard areas and designed to withstand the anticipated ground shaking.

An analysis of the utility systems which serve the City and the City's critical public facilities is contained in the previously prepared Technical Report. Specific hazards for the utility systems and critical facilities are discussed. The findings and conclusions are related to the policies contained in the final section of this report.

III. HAZARD REDUCTION

A. ORGANIZATION AND PURPOSE

The previous section of this document represents a synthesis of the existing seismic hazards in the City of Santa Monica and presents a technical evaluation of structural hazards. The intent of that section is to summarize the general framework within which planning for seismic safety should take place. In this section, recommendations are presented which encompass general planning goals and policies and technical recommendations pertaining to seismic design criteria. These recommended policies and criteria constitute the seismic safety plan for the City of Santa Monica.

B. GOAL RECOMMENDATIONS

To plan effectively for reducing hazards to acceptable levels of risk it is necessary that goals be set and adhered to. Goals address general policy directions which form the basis for planning decisions and actions. The goal and objective for seismic safety developed by the Citizens of the City of Santa Monica are:

Goal: Minimize the destructive effects of earthquakes.

Objectives:

1. Ensure that all structures are designed or modified to withstand earthquake motions and to minimize hazards to life from such motions.

2. Establish measures to provide vital services and implement evacuation and rescue programs during emergency.

3. Educate the public and train the essential personnel in ways to save lives, minimize suffering, repair damage and restore important services after a major earthquake, coordinate disaster relief with surrounding communities.

4. Assess and evaluate status of existing buildings as to earthquake safety and make the information available to the public.

The technical and planning recommendations of the next two sections complement the planning goals and define specific directions for the City to take in reducing natural hazards.

C. TECHNICAL RECOMMENDATIONS

1. Seismic Design Criteria

Geological studies, seismological findings and predictions, and earthquake risk analysis do not provide any safety for the community, unless they are translated into building regulations and adopted as part of the City's Building Code.

The earthquake hazard equation recommended for the structures in the Hazard Delineation section of this report was:

$$f\ (t) = f\ (e,s)$$

where:

t type of occupancy,

e magnitude of earthquake forces

s type of structure.

This formula is the base for the seismic design criteria. In the building code each parameter of this equation and its limits should be defined, and the relation of each to the others should be given as a set of solutions or as linear equations.

a. Type of Occupancy

Buildings and facilities should be divided into occupancy classes, based on the number of occupants, funcion and economic value. Classification in three general categories is recommended as follows.

- Most Critical Facilities
  (Critical-Continued Functioning)
  Those facilities and buildings which are vital to the community and must continue to function in the aftermath of the quake. For example, hospitals, civil defense communications, water supply facilities, fire and police facilities, telephone communication facility, electrical substations, evacuation route facilities, and City Hall.

- Critical Facilities

  Those facilities or systems whose continued functioning immediately after a quake is not absolutely essential, but which should be repairable or partially in operation within a reasonable period (hours to days depending on facility), or which should be capable of being zoned to isolate and cut off damaged sections and permit reintroduction of service, or those buildings which must not collapse because of the high levels of occupancy or high economic or historic value. For example: schools, theaters, auditoriums, clinics, drug stores, main food markets, food and drug warehouses, utility systems, communication systems, bridges, pipelines, major public areas including shopping centers, parks, convention and conference facilities, and all structures over five stories and buildings with more than 200 occupants, and with more than four occupants per 1000 square feet of area.

- Non-Critical Facilities

  The ordinary facilities and buildings not included above and not essential to the continued functioning of the community or to the general public safety or health.

b. Magnitude of Earthquake Forces

There are three main factors which determine how earthquake forces affect a given site: earthquake magnitude, location of building site, soil characteristics of the site. These factors are discussed in the following paragraphs.

- Earthquake magnitudes expected for the Santa Monica area are presented in the Technical Report. Events related to the Santa Monica Seismic risk analysis and design criteria are:

EXPECTED EARTHQUAKES	Recurrence	Magnitude
Newport-Inglewood fault	100 years	5.2
	150 years	5.6
	300 years	6.5
San Andreas fault	100-150 years (118 years elapsed)	8.5

Response spectra of the earthquakes are as given in the Technical Report for five different zones, and are the essential part of the earthquake design criteria.

The City is divided in two seismic zones in the Technical Report.

a. Response Spectra Zones

In the process of development of response spectra the city was divided into five different zones.

ZONE	DESCRIPTION
IQS and IIQS	Areas underlain by Terrace Deposits south of major Malibu Coast-Santa Monica Fault Zone Displacement.
IQN and IIQN	Areas underlain by Terrace Deposits north of major Malibu Coast-Santa Monica Fault Zone Displacement.
IT	Areas underlain by Pico Formation.

Roman numerals I and II indicate the distance of the zone from the Newport-Inglewood Fault Zone.

b. Hazard Zones

The City contains five hazard zones:

1. A fault trace zone,
2. Areas with landslide potential,
3. Areas with high liquefaction potential,

TABLE II-4
RISK RATING MATRIX

HAZARD ZONES	OCCUPANCY TYPE		
	NON-CRITICAL	CRITICAL	MOST CRITICAL
FAULT TRACE ZONE (HAZARD MANAGEMENT ZONE)	X	O	O
AREAS WITH LANDSLIDE POTENTIAL	O	O	O
AREAS WITH HIGH LIQUEFACTION POTENTIAL	X	Ø	Ø
AREAS WITH HIGH SETTLEMENT POTENTIAL	Ø	O	O
AREAS WITHOUT SPECIAL HAZARD	X	X	X

X PROVISIONALLY SUITABLE

Ø GENERALLY UNSUITABLE

O RESTRICTED

4. Areas with high settlement potential, and

5. Areas without special hazard.

Table II-4 shows restrictions on locating critical and most critical structures in these zones.

- Local soil conditions have considerable effect on the development of the seismic forces. Response spectra given in the Technical Report represent general conditions and give sufficiently accurate information for general purposes. For highrise buildings and special structures, individual response spectra must be developed.

c. Type of Structure

Behavior of a structure during an earthquake is closely related to the construction type of the building. Different construction materials have different ductility and strength values. Consequently, they react to the earthquake forces differently. When buildings are designed to remain functional, working stresses must be increased by one-third, or ultimate stresses with the coefficients recommended in UBC must be used. When buildings are analyzed for survivability, then yield stress should be considered.

Recommended ductility and damping factors for different types of structures are listed below:

Building Type	Ductility Factor	Damping Factor
Reinforced Masonry	1 to 1.5	10%
Reinforced Concrete		
with shear walls	1 to 1.5	10%
with ductile frames	2 to 3	5% to 10%
Structural Steel		
braced frames	2 to 3	5%
ductile frames	4	5%

Parameters of the earthquake hazard equation discussed in the above paragraphs can be related to each other in several steps. The Acceptable Risk Matrix shown in Table II-5 relates the building classifications to the design considerations. Risk factors presented in this matrix were determined at the May 21, 1975, citizens' meeting. Table II-6 explains the design considerations shown on Table II-5 and relates them to the design requirements and consequently to the acceptable design stresses. Table II-7 gives the basic structural design criteria for each class of building, combining the Table II-5 and Table II-6 requirements.

All elements shown on Table II-7 are known. Building classes are defined in above paragraphs. Response spectra for each earthquake and for each seismic zone are given in the Technical Report. Design stress levels are different for each structural material, and, in order to be uniform, values described or listed in UBC should be considered.

With the basic structural criteria given on Table II-7, and the ductility and damping factors listed above, criteria for dynamic analysis of any building in Santa Monica are established. It should be noted that, actually, there are two different criteria in Table II-7, for Non-Critical and Critical facilities. One criterion determines that the structure will stay functional; one criterion insures that the structure will not collapse. Since the design stresses and response spectra used in both analyses are different (in mathematical terms), the solution cannot be determined without investigating both parameters and their relationship. Consequently, base shear should be developed for both criteria, and the highest shear should be taken as the design force. In the design of high rise buildings, the problem becomes

TABLE II-5
ACCEPTABLE RISK MATRIX

OCCUPANCY CLASSIFICATION	LEVEL OF ACCEPTABLE RISK	
	[1]FUNCTIONING REQUIREMENTS	[1]SURVIVABILITY REQUIREMENTS
NON - CRITICAL FACILITIES	5.2 NI (100)	8.5 SA (100-150)
CRITICAL FACILITIES	5.6 NI (150) 8.5 SA (100-150)	6.5 NI (300)
MOST CRITICAL FACILITIES (CONTINUED FUNCTIONING)	6.5 NI (300) 8.5 SA (100-150)	———

Numbers are earthquake magnitudes in Richter Scale

NI - Newport-Inglewood Fault

SA - San Andreas Fault

( ) Recurrance Interval

1 - For design considerations see Table II-6

TABLE II-6

STRUCTURAL DESIGN CONSIDERATIONS FOR ACCEPTABLE RISK

LEVELS OF ACCEPTABLE RISK	STRUCTURAL DAMAGE	NON-STRUCTURAL DAMAGE	ACCEPTABLE STREET LEVELS IN STRUCTURES	DANGER TO LIVES	POST EARTHQUAKE USE
(1) FUNCTIONINC REQUIREMENTS (REMAINS FUNCTIONAL)	NONE	SOME (CAN BE REPAIRED WHILE IN OPERATION	UBC VALUES	NONE	REMAINS FUNCTIONAL
(1) SURVIVABILITY REQUIREMENTS (WILL NOT COLLAPSE)	DAMAGED BUT NO TOTAL COLLAPSE	EXTENSIVE (BUT NOT ENDANGER LIVES)	YIELD STRESSES	SOME	NONE OR AFTER EXTENSIVE REPAIR

(1) DESIGN CONSIDERATION LISTED IN TABLE II-5

TABLE II-

BASIC STRUCTURAL DESIGN CRITERIA

BUILDING OCCUPANCY CLASSIFICATION	DESIGN ELEMENT	STRUCTURAL CONSIDERATION	
		FUNCTIONING REQUIREMENTS	SURVIVABILITY REQUIREMENTS
NON-CRITICAL	RESPONSE SPECTRA	5.2 NI	8.5 SA
	DESIGN STRESS LEVEL	UBC VALUES	YIELD STRESS
CRITICAL	RESPONSE SPECTRA	5.6 NI 8.5 SA	6.5 NI
	DESIGN STRESS LEVEL	UBC VALUES	YIELD STRESS
MOST CRITICAL (CONTINUED FUNCTIONING	RESPONSE SPECTRA	6.5 NI 8.5 SA	-----------
	DESIGN STRESS LEVEL	UBC VALUES	-----------

Numbers are Earthquake Magnitudes in Richter Scale
NI Newport-Inglewood Fault
SA San Andreas Fault
UBC Values 1.33 times working stress or ultimate stresses with coefficients recommended in UBC.

more complicated, due to second and third mode force considerations. It may happen that story shears computed with different design criteria must be at the maximum for different floor levels. In high rise building design, it is advisable that story shears be computed for both criteria, and the envelope of story shears diagrams be used in the design of structural members.

Earthquake analysis of the structures by the dynamic analysis method is desirable and advisable; however, it is not practical in most cases. It is much easier and cheaper to design a building with established simple formulas. The proposed 1976 Uniform Code has one of the best earthquake requirements section in the world. However, regional seismic requirements of Santa Monica and acceptable risk determined in public meeting do not coincide with the requirements of the code, but may be used by the designers if a set of correlation factors are applied to the UBC to express requirements of the City.

Such correlation factors may be established simply by computing base shears of each class and type of building for various periods by the analysis method, considering only the first mode and then dividing with the base shears computed to the code requirements. Correlation factors should be computed for both functioning and survivability conditions separately, and the larger coefficient should be adopted.

Base shear computed for the survivability conditions should be adjusted for working stresses in order to be compatible with code values by multiplying them by : $\frac{\text{working stress X 1.33}}{\text{yield stress}}$

Since correlation factors will be computed for different zones, different classes of structures, and since the correlation factors represent numerical coefficients for site-structure resonance (due to their relation to response spectra), coefficients in the code representing the following three factors should be taken as numerical value 1.0.

These factors are:

Z zone coefficient,

I structural importance factor, and

S site structure resonance coefficient.

Ductility factor K, in the computation of code correlation factors, may be taken as 1.0, but coefficient K should stay in the formula. After this adjustment, the code formula used in the development of base shear will be:

$$V = GKCW$$

where:

V Base shear,

G Code correlation factor,

K Numerical ductility coefficient given in UBC,

C Numerical resonance effect factor as defined in UBC,

W Total dead load and partial load where required in UBC.

Correlation factors for buildings with periods below 0.30 may be given in a form shown on Table II-8. For frame buildings, correlation factors for each period interval may be shown on Table II-9.

TABLE II-8
CODE CORRELATION
FACTORS TABLE

BUILDING TYPE	OCCUPANCY CLASS	RESPONSE SPECTRA ZONES				
		IT	IQN	IIQN	IQS	IIQS
CONCRETE	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					
STEEL	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					

K = 1.000 T = (varies)

TABLE II-9
CODE CORRELATION
FACTORS TABLE

BUILDING TYPE	OCCUPANCY CLASS	RESPONSE SPECTRA ZONES				
		IT	IQN	IIQN	IQS	IIQS
WOOD	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					
MASONRY	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					
CONCRETE	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					
STEEL	NON-CRITICAL					
	CRITICAL					
	MOST CRITICAL					

K = 1.000, T = 0.30

Since the above recommendations are based on first mode effects of the earthquake, their application to the frame buildings should be limited. All buildings with periods 0.3 or less and all non-critical frame buildings may be designed using code correlation factors. The dynamic analysis method should be applied to all other frame buildings.

According to the new code requirements, lateral force on parts or portions of a building or other structures (F_p) will be computed by the following formula.

$$F_p = ZISC_pW_p$$

In order to have a compatible design between structures and their components, the above formula should be changed as base shear computations formula reading:

$$F_p = GC_pW_p$$

where:

- G Code correlation factor,
- C_p Numerical coefficient specified in UBC,
- W_p The weight of a portion of a structure.

S and I factors are eliminated, because the computed G factor signifies these coefficients as explained in above paragraphs.

During an earthquake, damaged nonstructural items represent a hazard to the lives as much as, if not more, than damaged structural items. Most of the safety provisions for nonstructural items in UBC are not intended for high risk seismic zones and, consequently, do not provide the required safety in such areas. All nonstructural items should be secured in place with connectors with sufficient capacity to resist the lateral forces computed by the above formula.

The State Administrative Code, Title 24, and the Building Code of the City of Los Angeles, have a number of additional safety requirements covering nonstructural items. Most of these requirements are advisable for inclusion in future building codes of Santa Monica.

Some of these requirements are:

- Ceilings should be braced.
- Fixtures or hanging equipment and pipes should have sufficient bracings.
- Raised floors should be built with horizontal bracing systems.
- Mechanical and electrical equipment and pipes should be secured in their places for lateral forces.
- All elevators should be designed with sufficient horizontal support to resist earthquake forces.
- Shelves, storage cabinets and racks should be secured in place for horizontal acceleration.

Using special coefficient C_p determined by the City Building official, horizontal design forces for nonstructural items should be computed by the formula given above (to compute lateral forces on parts or portions of the structures).

2. Criteria for Upgrading Existing Structures

Since all existing structures cannot be upgraded to the present code requirements, improvement criteria are required which will enhance the safety of existing structures and yet be capable of implementation. Nonstructural and structural items have different costs to upgrade, and the standards for each will be discussed separately.

a. Upgrading of nonstructural items

Past codes had insufficient seismic safety requirements and inadequate concern with nonstructural items. Consequently, in most older buildings a number of items in each building is unsafe. Usually, these items can be upgraded to current building code standards at a small cost.

It is recommended that non-structural items in all the "Critical", "Most Critical," and "Non-Critical" buildings with public access be upgraded to new code requirements. (The "new code" requirements are those discussed in this report and should be incorporated in future Santa Monica City Building Codes.)

b. Upgrading of Structural Items.

Upgrading requirements for existing structures will be related to the time of construction and subsequent significant code changes as shown below:

structures built prior to 1933 Riley Act,

structures built after 1933 Riley Act and before 1961 UBC,

structures built after 1961 UBC and before the New Code.

Since code requirements in these periods have differed, criteria to upgrade them will be different.

- Structures built prior to the 1933-Riley Act.

  These are mostly unreinforced masonry structures. The unsafe conditions of these buildings and the possible economic, social and political impact of enforced upgrading or destruction has been discussed previously. Obviously, all of these structures cannot be upgraded or condemmed at once. Therefore, to achieve realistic safety measures, two different upgrading criteria are suggested.

  1. Temporary upgrading criteria.

     This criteria is intended only for "Non-Critical", one or two story structures and only on a temporary basis. The objective of the criteria is to protect lives.

Most of the unreinforced masonry structures can be brought to a condition that will survive an expected earthquake without collapse by reinforcing roof and floor diaphragms, providing new connections between diaphragms and wall or tie beams, and by bracing existing walls or by adding some shear walls.

Design of such repair work should be done by a registered structural engineer on the basis of his engineering judgement rather than code requirements. The engineer should be free to evaluate the strength of the existing unconventional material and systems and should utilize new repair materials at their ultimate strength values rather than working stress values.

In order to prevent the temporary measures from becoming permanent solutions, building officials should determine the acceptable life for these repairs. The building owner should commit himself to a permanent solution at the end of a temporary period, prior to the issuance of a repair permit.

2. Permanent Upgrading Criteria

General consensus among engineers and building officals is that the cost of upgrading unreinforced masonry structures is always too high to justify such works. However there are some exceptional cases where repair may be worthwhile. This criteria is intended for the exceptions as well as other structures designed prior to 1933 Riley Act requirements.

Since the remaining life of these structures is relatively short, a liberal repair criteria is considered. Two alternative repair criteria are suggested.

a. A certain percentage of the base shear determined by the new code requirements may be used in upgrading design criteria, providing that the percentage is determined by the building officials for all buildings in this group.

b. Upgrade these buildings using the base shear computed for the survivability condition; assuming: (1) That the functional condition is not essential for these structures, and (2) They are classified as non-critical buildings.

o Structures built after 1933 Riley Act and before 1961 U.B.C.

Non-critical structures in this group do not require any special attention. Structures classified as "Critical" and "Most Critical" should be analyzed to determine if their present occupancy status should continue.

Criteria for such analysis should be in compliance with survivability requirements and in compliance with the certain percentage of functioning requirements, listed in basic design criteria Table II-7.

Percentage of the functioning requirements should be determined by the building officials, taking into consideration safety coefficents of materials used and length of the future use. of the facility.

O Structures built after the 1961 UBC to present.

Non-critical structures in this group do not require any special attention. Structures classified as "Critical" and "Most Critical" should be analyzed to determine if their present occupancy status should be permitted to continue. Criteria for such analysis should be in compliance with the requirements of the new Building Code.

3. Zoning Ordinance Modification

Modification of the City of Santa Monica's zoning ordinance to include a Hazard Management Overlay District (HMOD) is recommended. The purpose of the HMOD would be to regulate the uses which are permitted within areas of known geologic hazard. Since certain uses should not be located in areas of specific seismic hazard, an HMOD will enable the City to review specific uses when proposed in such hazard areas. The ordinance, when written, should conform to the requirements of Chapter 7.5 of the California Public Resources Code.

The HMOD should be superimposed on the existing zoning districts of the City. Uses permitted on those properties within an HMOD would be those permitted by the basic zoning district, e.g., R-1 - single-family, or C-2 - retail store, etc. Certain specific uses would require approval of the Planning Commission and City Council before locating within an HMOD. The list of uses requiring specific approval should include the following:

Schools, hospitals, theaters and auditoriums accommodating more than 50 persons; electrical substations and natural gas substations or storage facilities; gasoline or oil or chemical storage; hotels, motels or dormitories; facilities related to the provision of emergency services such as ambulance dispatch centers, police, fire, communications; transportation centers and transit stations.

The ordinance as described above is not intended to be less restrictive than is required by Sec. 2623 of the Public Resources Code, which states that the "site of every proposed new real estate development or structure for human occupancy shall be approved by the City." All uses to be located within an HMOD would require approval by the City in the form of a building permit. Certain uses as identified above would require special approval by the Planning Commission and City Council.

Designation of specific boundaries for the HMOD should be based on information current at the time of the ordinance adoption regarding the location of the fault traces and the areas of potential liquefaction and landslide. As the locations of the fault traces are more precisely established by current or future study, the boundaries of the HMOD should be modified accordingly. Where the HMOD is assigned on the basis of a fault trace, the HMOD should extend not more than 1/8 mile (660 feet) on either side of the trace, in accordance with the Alquist-Priolo Hazard Management Act. In instances where the trace cannot be reasonably defined or where the traces branch, the zone should be appropriately wider. Fees charged by the City in connection with the application for and granting of approval of uses within an HMOD can be established by the City. The disposition of the fees is specified in Sec. 2625 of the Code.

D. SEISMIC SAFETY POLICY AND IMPLEMENATION RECOMMENDATIONS

The State of California considers the threat of earthquake serious enough to require a Seismic Safety Element in the General Plan of all incorporated governmental bodies. At the same time, it should be realized that the threat of earthquake is not the same at all times or in all places. This Seismic Safety Element traces the impacts of probable earthquakes. The preceding discussions indicate that the City can initiate many specific actions to counter these anticipated impacts. The most important implications of seismic safety are in terms of building and disaster preparedness. The following represents a summation of planning actions the City can take in reducing seismic hazards. The following policies and implementation strategies are presented as recommendations for review and adoption by the City Council.

1. The City's Building and Safety Commission should review the Seismic Safety Element and make recommendations on seismic engineering requirements for a new Building Code. Preparation of the new code may require retaining an outside consultant. A consulting firm could prepare the outline of a proposed code and then present a recommended code to the Commission. After the new code is adopted, the Commission should continue to meet periodically to discuss the performance of the code, and recommend changes. Earthquake engineering has advanced in the past and will continue to advance in the future. One of the tasks of the Commission should be to review new techniques and technology and modify the code periodically.

The format of the code should be similar to the State of California Administrative Code Title 21. This code uses UBC section and sub-section numbers and notes the additional or deleted paragraphs. The code should include the design criteria (Table II-7), ductility and damping factors listed in previous sections, response spectra given in the Technical Report, definitive descriptions of occupancy classifications, and a list of occupancies.

2. Conduct seismic analyses of all public buildings and facilities classified as "most Critical" to determine what modifications and improvements are required to assure that each conforms to appropriate seismic standards. Priority should be given to the police and communications facilities and those fire facilities not recently evaluated and improved.

   Upgrading work of existing structures should be done in two categories:

   a. Upgrading of non-structural items

   Upgrading of non-structural items to the new code requirements can be accomplished by convincing the public of the importance and low cost of the upgrading operation. The City should implement an upgrading program and police it. Upgrading work should start with "most critical" buildings. Then "critical" and then "non-critical" buildings with public access should be upgraded.

b. Upgrading of Structural Items

All existing structures recommended for upgrading in the previous section should be surveyed and upgraded, or their occupancies changed. The upgrading program of of the structures should be done with a plan based on the priorities shown on Table III-1.

Listing all critical and most critical buildings in Table III-1 does not mean that all of these structures will require upgrading work. The intent is that owners of these structures should provide a satisfactory engineering report showing that their structures comply with the City upgrading criteria. If a structure does not comply with the criteria, then it can either be repaired or be used with different occupancy.

A City building upgrading program will require three actions at the first step.

1. Legislative action to provide the required authority to the building department.
2. Adoption of a new building code.
3. A survey of the existing structures.

All of this work can be started immediately. An interim code to cover the temporary design criteria for unreinforced masonry structures is advisable. The Building Department can take action on the unreinforced masonry structures, since adoption of a new code may be time consuming. Buildings can be surveyed by using the forms in Appendix B.

TABLE III-1

UPGRADING SEQUENCE MATRIX

Numbers show upgrading work sequence

OCCUPANCY TYPE	PRE 1933 RILEY ACT BUILDINGS	AFTER 1933 BEFORE 1961 UBC	AFTER 1961 UBC BEFORE NEW CODE
NON-CRITICAL	4	-	-
CRITICAL	2	5	7
MOST CRITICAL	1	3	6

3. Initiate the program recommended to alleviate the problem of unsafe unreinforced masonry structures in the City.

   The present unreinforced masonry structures are unsafe and require immediate action. All unreinforced masonry public assembly buildings, unreinforced masonry hotels, apartments and office structures should be inspected by the building officials of the City. Necessary actions should be taken immediately, regardless of their economic or social impacts. Other unreinforced masonry structures may be inspected and temporarily or permanently repaired as recommended above, according to a plan devised by the City. To inform the community of unreinforced masonry construction, the City should post signs on unsafe structures to inform all people entering them of the risks involved in entry, or should require the owner to do so.

4. Using the data and findings of the Technical Report, all utility systems should be evaluated by the responsible departments and agencies to determine means by which to reduce earthquake damage to the system and to determine improvements which will minimize service reduction in the aftermath of the expected earthquakes discussed in the study. Priority should be given to analysis of the susceptibility of the Arcadia Water Treatment Plant and a determination made of the improvements required, if any, to assure an adequate flow for fire protection even should the Arcadia Plant be damaged by ground rupture.

5. Control valves should be installed when major utility lines cross the Hazard Management Zones in locations which will permit the cut-off of flow and the isolation of a damaged section of line.
6. The City should consider relocating its central communication facility to a site outside a Hazard Management Zone. The proposed Mount Olivette site should be analyzed using seismic criteria as well as other criteria to determine its suitability. Continued function of this critical facility after an earthquake of the design magnitude is essential.
7. Evacuation routes designated in the Public Safety Element should be reviewed and alternative routes planned for in the event of damage to a designated route.
8. A Hazard Management Overlay District should be prepared and adopted as a part of the City's zoning ordinance.
9. The General Plan should be evaluated and updated incorporating the findings of the Seismic Safety Element. Particular emphasis should be given to Land Use, Circulation, Public Safety, and Open Space Elements.
10. The City should develop an information release program to familiarize the citizens of the region with the Seismic Safety Element (See Appendix C). School Districts and agencies related to aged, handicapped, and seismically susceptible industries should be encouraged to develop education programs relative to seismic awareness. Appropriate media for reaching different segments of the community (Spanish-speaking) should be established and presentations conducted. Builders and realtors in the City should be provided with the findings of the Seismic Safety Element.

11. The State and Federal governmental agencies should be encouraged to intensify research on seismic and other geologic hazards, with particular attention to expanding research with respect to the Alquist/Priolo zones.

12. Upon adoption of this Element, the City should establish a Seismic Safety Review Committee to oversee the implementation of this Element. This committee should include the City Manager, and the Directors of Public Works, Planning, Police, Fire, and Building.

13. Caltrans should review the Seismic Safety Element with respect to freeways and other major highways and should forward comments to the City.

14. Southern Pacific Transportation Company should review the Seismic Safety Element for possible impact on their transportation, storage, maintenance, and station facilities and should forward comments to the City.

15. The City's Building and Safety Commission should review the City's subdivision requirements, grading ordinance, and zoning ordinance and make recommendations for incorporating seismic safety. Procedures should be established for requiring geologic site investigations in areas of high hazard, particularly when critical facilities are involved.

16. The City's Emergency Plan (February 25, 1975) should be reviewed using the information provided in the Seismic Safety Element. Particular consideration should be given to upgrading emergency

communications and self-sufficiency within the City of Santa Monica. In the event of a major earthquake in Southern California, many cities and hundreds of thousands of people will be severely affected. It is likely that the Federal and State emergency services will be badly over-extended. It is advisable that the City of Santa Monica be prepared to serve itself and maintain continued functioning of necessary services rather than expect adequate aid from outside organizations. Periodic earthquake drills should be conducted by the City and coordinated on a regional basis in cooperation with all involved jurisdictions. Community programs that train volunteers to assist police, fire and civil defense personnel during and after a major earthquake should be established.

IV. RELATIONSHIP TO OTHER GENERAL PLAN ELEMENTS

The technical data compiled in the preparation of the Seismic Safety Element and presented in the Geotechnical Report can be utilized by planners engaged in the planning process. While the data is tentative in some respects, particularly in regard to precise locations of the two branches of the Malibu-Santa Monica fault, the findings and conclusions of the Seismic Element should be reflected in the regulations and controls placed on development within the City.

Because the Seismic Element is one of the last of the required General Plan Elements to be prepared by the City, some of the information and implications developed within the Seismic Element may not have been fully considered in the preparation of other General Plan Elements. Four General Plan Elements in particular should be reviewed to assure that each reflects the findings and recommendations of the Seismic Element. These four elements are: Land Use, Circulation, Safety and Open Space.

A. LAND USE ELEMENT

Land use patterns within the City of Santa Monica are well established and the Land Use Element largely reflects the existing land use pattern within the community. For this reason and because of the manner in which the two branches of the Malibu Coast-Santa Monica Fault cross the City, no substantial change in land use on or near these fault lines is considered possible or required for reasonable public safety. However the Land Use Map probably should be reviewed and modified in response to the Seismic Element findings, particularly the location of fault traces and areas of high potential for settlement, landslide or liquefaction.

The objective in applying the knowledge gained in the course of the Seismic Element should be to reduce the risk to life, to reduce the probability of property loss, and to ensure that critical public

facilities can continue to function after a major earthquake. Talbe II-4 presented earlier, illustrates in matrix form the occupancy types and activities and their relationship to various hazard zones which have been identified for the City. The most important factor illustrated in Table II-4 is that those uses and activities and buildings which are essential to the continued functioning of the City in the aftermath of an earthquake should be located in only those zones of lowest hazard. Other activities identified as critical and whose characteristics of either occupancy or operation warrant special attention, should be located only where design can assure that these will not collapse during the design earthquakes. The matrix, however, is not intended to provide a rigid definition of acceptable and unacceptable uses for each hazard zone. The suitability of a specific use for a location at a specific point should be evaluated in the light of current soils and geological information. An area evaluated as generally unsuitable for particular use does not necessarily preclude the use if no other suitable alternative site is available and provided that all potential hazards can be mitigated. However, if such hazards cannot be mitigated, prohibition of the use is the only alternative.

The Land Use Element of the General Plan is almost 20 years old and should be updated. When it is updated, recommendation for locating all facilities considered "most critical" or "critical" should be made with due regard to the hazard zones identified for the City.

B. CIRCULATION ELEMENT

The circulation network of the City of Santa Monica is well established, and the Circulation Element of the City largely reflects the existing condition. Major new circulation facilities are not proposed as part of the Circulation Element.

The circulation network could be substantially impacted by a moderate-to-large earthquake. Primary impact would be possible damage to the various overcrossings and undercrossings within the City and problems resulting from landslides along the Palisades. Any modification of existing circulation facilities, particularly modification at any crossing structure, should reflect the seismic data contained in the Technical Report. Any new construction should utilize the seismic response design criteria contained in that report.

C. PUBLIC SAFETY ELEMENT

The Emergency Evacuation Plan contained within the Public Safety Element of the General Plan designates escape corridors to be used in the event of emergencies declared by the Federal, State or local authorities. A major earthquake centered in or near the City could cause damage to the City's street and highway system, similar to that experienced in the Sylmar-San Fernando quake of February, 1971. The importance of evacuation routes to public safety may be somewhat less in an earthquake related disaster than in disasters of other types, such as atomic or military attack. Evacuation routes in an earthquake related disaster would be used only after the occurrence of the quake. Earthquake damage to the evacuation routes could hinder or prohibit movement of people and vehicles along the route.

Of the streets designated as evacuation routes in the Public Safety Element, Highway I is the most likely to suffer sufficient damage to disrupt traffic or be closed to traffic. Problems of several types could be expected as a result of an earthquake which could affect the continued function of this route, i.e., landslides, liquefaction and structure failure at the California Incline and the Colorado overcrossing. For this reason, alternatives to the use of Highway I as an evacuation route in the event of an earthquake should be studied by the City Staff, and alternative routes designated for use in the event of damage to designated routes.

D. OPEN SPACE ELEMENT

The Open Space Element of the City of Santa Monica designates the Palisades area along Ocean Avenue from the westerly City limits to Colorado as a park public use area. As an area of hazard, designation of the Palisades as a form of open spaces is appropriate. However, this area is subject to unpredictable slippage not necessarily earthquake related, and public use of this area particularly by organized groups such as school children should be discouraged. Its designation in the Open Space Plan (and Land Use Element) should reflect the condition of hazard which exists and which is not true of other park use areas.

APPENDIX A

GLOSSARY OF TERMS

Active Fault - One that has moved in recent geologic time and which is likely to move again in the relatively near future. Definitions for planning purposes extend on the order of 10,000 years or more back and 100 years or more forward.

Alluvial - Pertaining to or composed of alluvium, or deposited by a stream or running water. (AGI, 1972)

Alluvium - A general term for clay, silt, sand, gravel or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its flood plain or delta, or as a cone or fan at the base of a mountain slope. (AGI, 1972)

Amplification - Elaboration; augmentation; addition (Webster). As used herein, near-surface amplification is the augmentation of wave amplitude resulting from the change in physical properties in near-surface layers (see Introduction).

Amplitude - The extent of the swing of a vibrating body on each side of the mean position. (Webster)

Block Glide - A translational landslide in which the slide mass remains essentially intact, moving outward and downward as a unit, most often along a pre-existing plane of weakness such as bedding, foliation, joints, faults, etc. (AGI, 1972)

Cohesion - Shear strength in a sediment not related to interparticle friction. (AGI, 1972)

Colluvium - (a) A general term applied to any loose, heterogenous, and incoherent mass of soil, material or rock fragments deposited chiefly by mass-wasting, usually at the base of a steep slope or cliff. (b) Alluvium deposited by unconcentrated surface runoff or sheet erosion, usually at the base of a slope. (AGI, 1972)

Compaction - Reduction in bulk volume or thickness of, or the pore space within, a body of fine-grained sediments in response to the increasing weight of overlying material that is continually being deposited, or to the pressure resulting from earth movements within the crust. It is expressed as a decrease in porosity brought about by a tighter packing of the sediment particles. (AGI, 1972)

Consolidated Material - Soil or rocks that have become firm as a result of compaction.

Critical Damping - Damping to the point at which the displaced mass just returns to its original position without oscillation. (AGI, 1972).

Damping - The resistance to vibration that causes a decay of motion with time or distance, e.g. the diminishing amplitude of an oscillation. (AGI, 1972)

Differential Settlement - Nonuniform settlement; the uneven lowering of different parts of an engineering structure, often resulting in damage to the structure. (AGI, 1972)

Displacement (Geological) - The relative movement of the two sides of a fault, measured in any chosen direction; also, the specific amount of such movement. Displacement in an apparently lateral direction includes strike-slip and strike separation; displacement in an apparently vertical direction includes dip-slip and dip separation. (AGI, 1972)

Displacement (Engineering) - The geometrical relation between the position of a moving object at any time and its original position. (Webster)

Epicenter - That point on the Earth's surface which is directly above the focus of an earthquake. (AGI, 1972)

Fault - A surface or zone of rock fracture along which there has been displacement, from a few centimeters to a few kilometers in scale. (AGI, 1972)

Fault Surface - In a fault, the surface along which displacement has occurred. (AGI, 1972)

Fault System - Two or more interconnecting fault sets. (AGI, 1972)

Fault Zone - A fault zone is expressed as a zone of numerous small fractures or by breccia or fault gouge. A fault zone may be as wide as hundreds of meters. (AGI, 1972)

Focus (Seism) - That point within the Earth which is the center of an earthquake and the origin of its elastic waves. Syn: hypocenter; seismic focus; centrum (see Introduction). (AGI, 1972)

Ground Response - A general term referring to the response of earth materials to the passage of earthquake vibration. It may be expressed in general terms (maximum acceleration, dominant period, etc.), or as a ground-motion spectrum.

Hypocenter - See focus.

Intensity (earthquake) - A measure of the effects of an earthquake at a particular place on human and/or structures. The intensity at a point depends not only upon the strength of the earthquake, or the earthquake magnitude, but also upon the distance from the point to the epicenter and the local geology at the point. (AGI, 1972)

Isoseismal line - A line connecting points on the Earth's surface at which earthquake intensity is the same. It is usually a closed curve around the epicenter. Syn: isoseism; isoseismic line; isoseismal. (AGI, 1972)

Liquefaction - A sudden large decrease in the shearing resistance of a cohesionless soil, caused by a collapse of the structure by shock or strain, and associated with a sudden but temporary increase of the pore fluid pressure. (AGI, 1972)

Macroseismic data - Used herein to describe instrumentally recorded earthquakes generally in the range of Richter magnitude 3.0 or more. (This use differs from the AGI definition of "macroseismic observations").

Magnitude (earthquake) - A measure of the strength of an earthquake or the strain energy released by it, as determined by seismographic observations. As defined by Richter, it is the logarithm, to the base 10, of the amplitude in microns of the largest trade deflection that would be observed on a standard torsion seismograph (static magnification = 2800; period = 0.8 sec; damping constant = 0.8) at a distance of 100 kilometers from the epicenter. (AGI, 1972)

Microseismic data - Used herein to describe instrumentally recorded earthquakes generally in the range of Richter magnitude 3.0 or less. (This use is consistent with the AGI definition of microseism and microseismometer, but is more restricted than their definition of microseismic data).

Natural period - The period at which maximum response of a system occurs. The inverse of resonant frequency.

Normal fault - A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of the fault is usually 45-90 degrees. This is dip-separation, but there may or may not be dip-slip. (AGI, 1972)

Predominant period - The period of the acceleration, velocity or displacement which predominates in a complex vibratory motion. In the analysis of earthquake vibrations, predominant period is normally the period of the maximum amplitude of the acceleration spectrum.

Response spectrum - An array of the response characteristics of a structure or structures ordered according to period or frequency. The structures are normally single-degree-of-freedom oscillators, and the characteristics may be displacement, velocity or acceleration (see Introduction).

Seiche - All standing waves on any body of water whose period is determined by resonant characteristics of the containing basin as controlled by its physical dimensions. (U.S. Geol. Survey Prof. Paper 544-E)

Seismic seiche - Standing waves set up on rivers, reservoirs, ponds and lakes at the time of passage of seismic waves from an earthquake. (U.S. Geol. Survey Prof. Paper 544-E)

Shear - A strain resulting from stresses that cause or tend to cause contiguous parts of a body to slide relatively to each other in a direction parallel to their plane of contact; specifically, the ratio of the relative displacement of these parts to the distance between them. (AGI, 1972)

Shear wave or S-wave - That type of seismic body wave which is propagated by a shearing motion of material so that there is oscillation perpendicular to the direction of propagation. It does not travel through liquids. (AGI, 1972)

Slip - On a fault, the actual relative displacement along the fault plane of two formerly adjacent points on either side of the fault. Slip is three dimensional, whereas separation is two dimensional. (AGI, 1972)

Strike-slip fault - A fault, the actual movement of which is parallel to the strike (trend) of the fault. (AGI, 1972)

Subsidence - A local mass movement that involves principally the gradual downward settling or sinking of the solid Earth's surface with little or no horizontal motion and that does not occur along a free surface (not the result of a landslide or failure of a slope. (AGI, 1972)

Tectonic - Of or pertaining to the forces involved in, or the resulting structures or features of the upper part of the Earth's crust. (mod. from AGI, 1972)

Tsunami - A gravitational sea wave produced by any large-scale, short-duration disturbance of the ocean floor, principally by a shallow submarine earthquake, but also by submarine earth movement, subsidence, or volcanic eruption, characterized by great speed of propagation (up to 950 km/hr.), long wavelength (up to 200 dm.), long period (5 min. to a few hours, generally 10 - 60 min.), and low observable amplitude on the open sea, although it may pile up to great heights (30 m. or more) and cause considerable damage on entering shallow ater along an exposed coast, often thousands of kilometers from the source. (AGI, 1972)

Unconsolidated material - A sediment that is loosely arranged or unstratified or whose particles are not cemented together, occurring either at the surface or at depth. (AGI, 1972)

Water table - The surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere. (AGI, 1972)

APPENDIX B

BUILDING SURVEY FORMS

BUILDING SURVEY FORM

PART I

<table>
<tr><td>SURVEYING OFFICER</td><td colspan="7">DATE</td></tr>
<tr><td>ADDRESS</td><td colspan="7"></td></tr>
<tr><td>BLOCK</td><td colspan="3"></td><td>LOT</td><td colspan="3"></td></tr>
<tr><td>SANBORN MAP REFERENCE</td><td colspan="7"></td></tr>
<tr><td>OWNER NAME, ADDRESS</td><td colspan="7"></td></tr>
<tr><td>OCCUPANT ADDRESS</td><td colspan="3"></td><td colspan="4">OWNER RESIDENT
RENTED
LEASED</td></tr>
<tr><td>OCCUPANCY</td><td colspan="3"></td><td>OCCUPANCY TYPE</td><td colspan="3"></td></tr>
<tr><td>VALUE</td><td colspan="3"></td><td>NO. OF OCCUPANTS</td><td colspan="3"></td></tr>
<tr><td>BUILDING TYPE</td><td colspan="3"></td><td>YEAR BUILT</td><td colspan="3"></td></tr>
<tr><td>PLAN DIMENSIONS</td><td colspan="3"></td><td>HEIGHT</td><td colspan="3"></td></tr>
<tr><td>TOTAL BUILDING AREA</td><td colspan="3"></td><td>LOT AREA</td><td colspan="3"></td></tr>
<tr><td rowspan="3">ADJOINING BUILDINGS</td><td>SIZE</td><td>SEPARATION</td><td></td><td>HEIGHT</td><td></td><td>OCCP. TYPE</td><td></td></tr>
<tr><td>SIZE</td><td>SEPARATION</td><td></td><td>HEIGHT</td><td></td><td>OCCP. TYPE</td><td></td></tr>
<tr><td>SIZE</td><td>SEPARATION</td><td></td><td>HEIGHT</td><td></td><td>OCCP. TYPE</td><td></td></tr>
<tr><td>EARTHQUAKE RESISTING SYSTEM</td><td colspan="7"></td></tr>
<tr><td>VERTICAL LOAD CARRYING SYSTEM</td><td colspan="7"></td></tr>
<tr><td>FOUNDATIONS</td><td colspan="7"></td></tr>
<tr><td>WALLS</td><td colspan="7"></td></tr>
<tr><td>PHYSICAL CONDITION</td><td colspan="7"></td></tr>
</table>

BUILDING SURVEY FORM

PART II

ONLY FOR THE STRUCTURES BUILT PRIOR TO 1933 AND BUILDINGS WITH SPECIAL HAZARDS	
LOAD CARRYING WALLS	
PARTITIONS	
ROOF DIAPHRAGMS	
WALL DIAPHRAGMS CONNECTIONS	
UNANCHORED MASONRY VENEER	
UNSAFE NON-STRUCTURAL ITEMS	
OVERHANGS	
PARAPETS	
SKETCH OF THE BUILDING	

APPENDIX C

EARTHQUAKE SAFETY PROCEDURES

EARTHQUAKE SAFETY PROCEDURES

Before an Earthquake

1. Potential earthquake hazards in the home should be removed or corrected. Top-heavy objects and furniture, such as bookcases and storage cabinets, should be fastened to the wall and the largest and heaviest objects placed on lower shelves. Water heaters and other appliances should be firmly bolted down, and flexible connections should be used whenever possible.

2. Supplies of food and water, flashlight, a first-aid kit, and a battery-powered radio should be set aside for use in emergencies. Of course, this is advisable for other types of emergencies, as well as for earthquakes.

3. One or more members of the family should have a knowledge of first aid procedures because medical facilities nearly always are overloaded during an emergency or disaster, or may themselves be damaged beyond use.

4. All responsible family members should know what to do to avoid injury and panic. They should know how to turn off the elctricity, water, and gas; they should know the locations of the main switch and valves. This is particularly important for teenagers who are likely to be alone with smaller children.

5. It is most important for a resident of California to be aware that this is "earthquake country" and that earthquakes are most likely to occur again where they have occurred before. Building codes that require earthquake-resistant construction should be vigorously supported and, when enacted into law, should be rigorously enforced. If effective building codes and grading ordinances do not exist in your community, support their enactment.

During An Earthquake

1. The most important thing to do during an earthquake is to remain calm. If you can do so, you are less likely to be injured. If you are calm, those around you will have a greater tendency to stay calm, too. Make no moves or take no action without thinking about the possible consequences. Motion during an earthquake is not constant; commonly, there are a few seconds between tremors.

2. If you are inside a building, stand in a strong doorway or get under a desk, table, or bed. Watch for falling plaster, bricks, light fixtures, and other objects. Stay away from tall furniture, such as china cabinets, bookcases, and shelves. Stay away from windows, mirrors, and chimneys. In tall buildings, it is best to get under a desk if it is securely fastened to the floor, and to stay away from windows or glass partitions.

3. Do not rush outside. Stairways and exits may be broken or may become jammed with people. Power for elevators and escalators may have failed. Many of the 115 persons who perished in Long Beach and Compton in 1933 ran outside only to be killed by falling debris and collapsing chimneys. If you are in a crowded place such as a theater, athletic stadium, or store, do not rush for an exit because many others will do the same thing. If you must leave a building, choose your exit with care and, when going out, take care to avoid falling debris and collapsing walls or chimneys.

4. If you are outside when an earthquake strikes, try to stay away from high buildings, walls, power poles, lamp posts, or other structures that may fall. Falling or fallen electrical power lines must be avoided. If possible, go to an open area away from all hazards but do not run through the streets. If you are in an automobile, stop in the safest possible place, which, of course, would be an open area, and remain in the car.

<u>After An Earthquake</u>

1. After an earthquake, the most important thing to do is to check for injuries in your family and in the neighborhood. Seriously injured persons should not be moved unless they are in immediate danger of further injury. First aid should be administered, but only by someone who is qualified.

2. Check for fires and fire hazards. If damage has been severe, water lines to hydrants, telephone lines, and fire alarm systems may have been broken; contacting the fire department may be difficult. Some cities, such as San Francisco, have auxiliary water systems and large cisterns in addition to the regular system that supplies water to fire hydrants. Swimming pools, creeks, lakes, and fish ponds are possible emergency sources of water for fire fighting.

3. Utility lines to your house - gas, water, and electricity - and appliances should be checked for damage. If there are gas leaks, shut off the main valve which is usually at the gas meter. Do not use matches, lighters, or open-flame appliances until you are sure there are no gas leaks. Do not use electrical switches or appliances if there are gas leaks, because they give off sparks which could ignite the gas. Shut off the electrical power if there is damage to the wiring; the main switch usually is in or next to the main fuse or circuit breaker box. Spilled flammable fluids, medicines, drugs, and other harmful substances should be cleaned up as soon as possible.

4. Water lines may be damaged to such an extent that the water may be off. Emergency drinking water can be obtained from water heaters, toilet tanks, canned fruits and vegetables, and melted ice cubes. Toilets should not be flushed until both the incoming water lines and outgoing sewerlines have been

checked to see if they are open. If electrical power is off for any length of time, plan to use the foods in your refrigerator and freezer first before they are spoiled. Canned and dried foods should be saved until last.

5. There may be much shattered glass and other debris in the area, so it is advisable to wear shoes or boots and a hard hat if you own one. Broken glass may get into foods and drinks. Liquids can be either strained through a clean cloth such as a handkerchief or decanter. Fireplaces, portable stoves, or barbecues can be used for emergency cooking but the fireplace chimney should be carefully checked for cracks and other damages before being used. In checking the chimney for damage, it should be approached cautiously, because weakened chimneys may collapse with the slightest of aftershocks. Particular checks should be made of the roof line and in the attic because unnoticed damage can lead to a fire. Closets and other storage areas should be checked for objects that have been dislodged or have fallen, but the doors should be opened carefully because of objects that may have fallen against them.

6. Do not use the telephone unless there is a genuine emergency. Emergencies, and damage reports, alerts, and other infomation can be obtained by turning on your radio. Do not go sightseeing; keep the streets open for the passage of emergency vehicles and equipment. Do not speculate or repeat the speculations of other - this is how rumors start.

7. Stay away from beaches and other waterfront areas where seismic sea waves (tsunamis), sometimes called "tidal waves", could strike. Again, your radio is the best source of information concerning the likelihood that a seismic sea wave will occur. Also stay away from steep landslide-prone areas if possible, becuase aftershocks may trigger a landslide or avalnche, especially if there has been a lot of rain and the ground is nearly saturated. Also stay away from earthquake-damaged structures. Additional earthquake shocks known as "aftershocks" normally occur after the main shock, sometimes over a period of several months. These are usually smaller than the main shock but they can cause damage, too, particularly to damaged and already weakened structures.

8. Parents should stay with young children who may suffer psychological trauma if parents are absent during the occurrence of aftershocks.

9. Cooperate with all public safety and relief organizations. Do not go into damaged areas unless authorized; you are subject to arrest if you get in the way of, or otherwise hinder, rescue operations. Martial law has been declared in a number of earthquake disasters. In the 1906 disaster in San Francisco, several looters were shot.

10. Send information about the earthquake to the Seismological Field Survey to help earth scientists understand earthquakes better.

APPENDIX D

SUMMARY OF SIGNIFICANT COURT DECISIONS AND LEGISLATION

Summary of Significant Court Decisions and Legislation

(Source: Urban Geology Master Plan for California, 1973)

In recent years there have been many attempts by government to reduce losses from geologic hazards. The following summaries are some of the more important ones.

COURT DECISIONS

1. Sheffet decision (Los Angeles Superior Court Case No. 32487): Declared that a public entity is liable for damages to adjacent property resulting from improvements planned, specified or authorized by the public entity in the exercise of its governmental power. (The State Supreme Court refused to rehear this decision, which establishes a judicial precedent.)

2. L.A. County Superior Court (Case No. 684595 and consolidated cases): This decision found the County liable for damages which may have resulted from roadwork and the placement of fill by the County. This case was in regard to the Portuguese Bend landslide, Palos Verdes Hills, Los Angeles County, California.

3. City of Bakersfield vs Miller (48 Cal. Rptr. 889), heard in the State Supreme Court 1966: This decision affirms that the city may declare an older structure not in compliance with the newly adopted Uniform Building Code to be a public nuisance. Further, the city may enforce abatement of the non-conforming condition even though to do so may require the building to be demolished.

4. Burgess vs. Conejo Valley Development Co. (Connor vs. Great Western Savings and Loan Association) (73 Cal. Rptr. 369) heard in the State Supreme Court in 1968, concerning damage to tract homes from expansive soil in Thousand Oaks, Ventura County: This decision affirmed that the home buyer, both first buyer and all subsequent ones, has the right to protection from negligent construction practice leading to damage. In this case, neither contractor, county inspectors, nor representatives of the major lending institution acted to ascertain expansive soil conditions, or to prevent damage from them.

5. Oakes vs. The McCarthy Co. (California Appellate Reports, 2d Series, 267, 1968) the court held that in the Palos Verdes area, Los Angeles County, a developer and soils engineering company could be liable in negligence for damages to a home resulting from using improper (clay) fill material and improperly compacting that fill so that earth movement resulted. Also, the court awarded punitive damages against the developer for fraudulent conceal-

ment of material facts concerning the property, i.e., failure to volunteer to the prospective buyer that the house was built upon fill.

LEGISLATION

PUBLIC RESOURCES CODE

Section 660-662 and 2621-2625: These sections require the State Geologyst to delienate special studies zones encompassing potentially and recently active fault traces. It requires cities and counties to exercise specified approval authority with respect to real estate developments or structures for human occupancy within such delineated zones.

Section 2700-2708: These sections require the Division of Mines and Geology to purchase and install strong-motion instruments (to measure the effects of future earthquakes) in representative structure and geologic environments throughout the state.

Section 2750: Establishes a state mining and minerals policy which, among other things, encourages wise use of mineral resources.

EDUCATION CODE

Section 15002.1: This section requires that geological and soils engineering studies by conducted on all new school sites and on existing sites where deemed necessary by the Department of General Services.

Section 15451-15466: These sections constitute the Field Act and require that public schools be designed for the protection of life and property. These sections, enacted in 1933 after the Long Beach earthquake, are enforced by the State Office of Architecture and Construction in accordance with regulations contained in Title 21 of the California Administrative Code.

HEALTH AND SAFETY CODE

Sections 15000 et seq.: These sections require that geological and engineering studies by conducted on each new hospital or additions affecting the structure on an existing hospital, excepting therefrom one story Type V buildings 4000 sq. ft. or less in area.

Sections 19100-19150: These sections constitute the Riley Act and require certain buildings to be constructed to resist lateral forces, specified in Title 24 California Administrative Code.

Section 17922, 17951-17958.7: These sections require cities and counties to adopt and enforce the Uniform Building Code, including a grading section (chap. 70), a minimum protection against some geologic hazards.

BUSINESS AND PROFESSIONAL CODE

Section 7800-7887: These sections provide for the registration of geologists and geophysicists, and the certification of certain geologists in the specialty of engineering geology.

Section 11010: This section requires that a statement of the soil conditions be prepared and needed modifications be carried out in accordance with the recommendations of a registered civil engineer.

Section 11100-11629: These sections require studies in subdivisions to evaluate the possibilities of flooding and unfavorable soils.

GOVERNMENT CODE

Section 8589.5: This section requires that inundation maps and emergency evacuation plans be completed for areas subject to inundation by dam failure.

Section 65300-65302.1: These sections require that each city and county shall adopt the following elements:

Seismic Safety Element consisting of the identification and appraisal of seismic hazards including an appraisal of landsliding due to seismic events.

Conservation element including the conservation, development and utilization of minerals.

Safety element including protection of the community from geologic hazards including mapping of know geologic hazards.

APPENDIX E

ALQUIST-PRIOLO HAZARD MANAGEMENT ACT

1. Text of Act
2. Policies and Criteria of the State Mining & Geology Board
3. Explanation of Special Studies Compiled by the State Geologist
4. Zoning for Surface Fault Hazards in California: The New Special Studies Zones Maps

Senate Bill No. 520

CHAPTER 1354

An act to amend Sections 660, 661, and 662 of, and to add Chapter 7.5 (commencing with Section 2621) to Division 2 of, the Public Resources Code, relating to earthquake protection, and making an appropriation therefor.

[Approved by Governor December 22, 1972. Filed with Secretary of State December 22, 1972.]

LEGISLATIVE COUNSEL'S DIGEST

SB 520, Alquist. Earthquake protection.

Increases the membership of the State Mining and Geology Board from 9 to 11 persons and declares that persons with specified occupations should be selected for membership on the board. Designates the board as a policy and appeals board for the purposes of provisions re earthquake hazard zones.

Requires the State Geologist to delineate, by December 31, 1973, special studies zones encompassing certain areas of earthquake hazard. Requires State Geologist to compile maps delineating the special studies zones and to submit such maps to affected cities, counties, and state agencies for review and comment. Requires the State Geologist to continually review new geologic and seismic data and revise special studies zones and submit such revisions to affected cities, counties, and state agencies for review and comment. Appropriates $100,000 for such purposes. Requires affected cities, counties, and state agencies to submit their comments to board.

Requires cities and counties to exercise specified approval authority with respect to real estate developments or structures for human occupancy within such delineated zones. Requires applicants for a building permit within such zone to be charged a fee according to a fee schedule established by the board. Limits maximum amount of such fee. Provides for retention of ½ of the proceeds of any such fee by the city or county having jurisdiction and transfer of ½ to the state.

The people of the State of California do enact as follows:

SECTION 1. Section 660 of the Public Resources Code is amended to read:

660. There is in the department a State Mining and Geology Board, consisting of 11 members appointed by the Governor, subject to confirmation by the Senate, for terms of four years and until their successors are appointed and qualified. The State Mining and Geology Board shall also serve as a policy and appeals board for the purposes of Chapter 7.5 (commencing with Section 2621) of Division 2.

SEC. 2. Section 661 of the Public Resources Code is amended to read:

661. Members of the board shall be selected from citizens of this state associated with or having broad knowledge of the mineral industries of this state, of its geologic resources, or of related technical and scientific fields, to the end that the functions of the board as specified in Section 667 are conducted in the best interests of the state. Among the 11 members, two should be mining geologists, mining engineers, or mineral economists, one should be a structural engineer, one should be a geophysicist, one should be an urban or regional planner, one should be a soils engineer, two should be geologists, one should be a representative of county government, and at least two shall be members of the public having an interest in and knowledge of the environment.

SEC. 3. Section 662 of the Public Resources Code is amended to read:

662. The terms of the members of the board in office when this article takes effect in 1965 shall expire as follows: one member January 15, 1966; two members January 15, 1967; and two members January 15, 1968. The terms shall expire in the same relative order as to each member as the term for which he holds office before this article takes effect. The terms of the two additional members first appointed pursuant to the amendment of this section at the 1968 Regular Session of the Legislature shall commence on January 15, 1969. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1970 Regular Session of the Legislature shall commence on January 15, 1971, but the term of one of such additional members, who shall be designated by the Governor, shall expire on January 15, 1974. The terms of the two additional members first appointed pursuant to the amendment of Section 660 at the 1972 Regular Session of the Legislature shall commence on January 15, 1973, but the term of one of such additional members, who shall be designated by the Governor, shall expire on January 15, 1976.

SEC. 4. Chapter 7.5 (commencing with Section 2621) is added to Division 2 of the Public Resources Code, to read:

CHAPTER 7.5. HAZARD ZONES

2621. This chapter shall be known and may be cited as the Alquist-Priolo Geologic Hazard Zones Act.

2621.5. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties, as well as to implement such general plan as may be in effect in any city or county. The Legislature declares that the provisions of this chapter are intended to provide policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibility to provide for the public safety in hazardous fault zones.

2622. In order to assist cities and counties in their planning, zoning, and building-regulation functions, the State Geologist shall delineate, by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults, or segments thereof, as he deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. Such special studies zones shall ordinarily be one-quarter mile or less in width, except in circumstances which may require the State Geologist to designate a wider zone.

Pursuant to this section, the State Geologist shall compile maps delineating the special studies zones and shall submit such maps to all affected cities, counties, and state agencies, not later than December 31, 1973, for review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 90 days. Within 90 days of such review, the State Geologist shall provide copies of the official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

The State Geologist shall continually review new geologic and seismic data and shall revise the special studies zones or delineate additional special studies zones when warranted by new information. The State Geologist shall submit all such revisions to all affected cities, counties, and state agencies for their review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 30 days. Within 30 days of such review, the State Geologist shall provide copies of the revised official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

2623. Within the special studies zones delineated pursuant to Section 2622, the site of every proposed new real estate development or structure for human occupancy shall be approved by the city or county having jurisdiction over such lands in accordance with policies and criteria established by the State Mining and Geology Board and the findings of the State Geologist. Such policies and criteria shall be established by the State Mining and Geology Board not later than December 31, 1973. In the development of such policies and criteria, the State Mining and Geology Board shall seek the comment and advice of affected cities, counties, and state agencies. Cities and counties shall not approve the location of such a development or structure within a delineated special studies zone if an undue hazard would be created, and approval may be withheld pending geologic and engineering studies to more adequately define the zone of hazard. If the city or county finds that no undue hazard exists, geologic and engineering studies may be waived, with approval of the State Geologist, and the location of the proposed development or structure may be approved.

2624. Nothing in this chapter is intended to prevent cities and counties from establishing policies and criteria which are stricter than those established by the State Mining and Geology Board, nor from imposing and collecting fees in addition to those required under this chapter.

2625. Each applicant for a building permit within a delineated special studies zone shall be charged a reasonable fee according to a fee schedule established by the State Mining and Geology Board. Such fees shall be set in an amount sufficient to meet, but not to exceed, the costs to state and local government of administering and complying with the provisions of this chapter. Such fee shall not exceed one-tenth of 1 percent of the total valuation of the proposed building construction for which the building permit is issued, as determined by the local building official. One-half of the proceeds of such fees shall be retained by the city or county having jurisdiction over the proposed development or structure for the purpose of implementing this chapter, and the remaining one-half of the proceeds shall be deposited in the General Fund.

SEC. 5. There is hereby appropriated from the General Fund in the State Treasury to the Department of Conservation the sum of one hundred thousand dollars ($100,000) for the purposes of Section 2622 of the Public Resources Code.

Amendment to Alquist-Priolo Geologic Hazard Zones Act

SUMMARY OF MAIN IMPACTS OF SB 2422

1. Local governments shall charge a fee sufficient to meet their costs, not limited to 1/10 of 1 percent of value of development.

2. Entire fee will remain with local government, not shared 1/2 with State.

3. State Geologist must define "new real estate development", and "structure for human occupancy" for purposes of the Act.

4. Fees to cover "each applicant for a site approval new real estate development or structure for human occupancy" (new) vs. "each applicant for a building permit" (old).

Senate Bill No. 2422

CHAPTER 1341

An act to amend Sections 2623 and 2625 of the Public Resources Code, relating to geologic hazards.

[Approved by Governor September 26, 1974. Filed with Secretary of State September 26, 1974.]

LEGISLATIVE COUNSEL'S DIGEST

SB 2422, Alquist. Geologic hazards.

Requires cities and counties to charge a reasonable fee to an applicant for a site approval for a proposed new real estate development (defined to include a subdivision) or structure for human occupancy located within a special studies zone delineated pursuant to the Alquist-Priolo Geologic Hazard Zones Act, rather than requiring such fee for a building permit according to a fee schedule established by the State Mining and Geology Board, and makes related changes. Requires the State Geologist to define "new real estate development" and "structure for human occupancy" for purposes of the act. Deletes the provisions limiting the maximum amount of such fees that may be charged and the provisions requiring ½ of the proceeds of fees imposed under the act to be retained by the city or county and the remaining ½ to be deposited in the General Fund.

Provides that neither appropriation is made nor obligation created for the reimbursement of any local agency for any costs incurred by it pursuant to the act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Section 2623 of the Public Resources Code is amended to read:

2623. Within the special studies zones delineated pursuant to Section 2622, the site of every proposed new real estate development or structure for human occupancy shall be approved by the city or county having jurisdiction over such lands in accordance with policies and criteria established by the State Mining and Geology Board and the findings of the State Geologist. The State Geologist shall, by regulation, define "new real estate development" and "structure for human occupancy" for the purposes of this chapter; provided, however, that a new real estate development shall include a subdivision as defined in the Subdivision Map Act (commencing with Section 11500, Business and Professions Code). Such policies and criteria shall be established by the State Mining and Geology Board not later than December 31, 1973. In the development of such policies and criteria, the State Mining and Geology Board shall seek the comment and advice of affected cities, counties, and state agencies. Cities and counties shall not approve the location of such a development or structure within a delineated special studies zone if an undue hazard would be created, and approval may be withheld pending geologic and engineering studies to more adequately define the zone of hazard. If the city or county finds that no undue hazard exists, geologic and engineering studies may be waived, with approval of the State Geologist, and the location of the proposed development or structure may be approved.

SEC. 2. Section 2625 of the Public Resources Code is amended to read:

2625. (a) Each applicant for a site approval for a new real estate development or structure for human occupancy within a delineated special studies zone shall be charged a reasonable fee by the city or county having jurisdiction over the proposed development or structure.

(b) Such fees shall be set in an amount sufficient to meet, but not to exceed, the costs to local government of administering and complying with the provisions of this chapter.

(c) The geologic and engineering studies specified in Section 2623 shall be in sufficient detail to meet the criteria and policies established by the State Mining and Geology Board for individual parcels of land.

SEC. 3. No appropriation is made by this act, nor is any obligation created thereby under Section 2231 of the Revenue and Taxation Code, for the reimbursement of any local agency for any costs that may be incurred by it in carrying on any program or performing any service required to be carried on or performed by it by this act because any such costs shall be recovered from fees collected pursuant to this act.

AMENDED IN SENATE FEBRUARY 17, 1975

AMENDED IN SENATE JANUARY 13, 1975

SENATE BILL No. 5

Introduced by Senator Alquist
(Coauthor: Assemblyman Suitt)

December 2, 1974

An act to amend *the heading of Chapter 7.5 (commencing with Section 2621) of Division 2 and* Sections 2621, 2621.5, *2622,* 2623, and 2625 of, and to add ~~Section 2621.7~~ *Sections 2621.6, 2621.7, 2621.8, and 2621.9* to, the Public Resources Code, relating to geologic hazards, and declaring the urgency thereof, to take effect immediately.

LEGISLATIVE COUNSEL'S DIGEST

SB 5, as amended, Alquist. ~~Geologic~~ *Surface fault rupture* hazard: *special* studies zones.

(1) The Alquist-Priolo Geologic Hazard Zones Act, among other things, requires the State Geologist to delineate special studies zones encompassing certain areas of earthquake hazard, the compilation of maps delineating such zones, and cities and counties to exercise approval authority with respect to a site approval for a proposed new real estate development (defined to include a subdivision as defined in the Subdivision Map Act) or for a structure for human occupancy located within a delineated zone.

This bill would rename such act the Alquist-Priolo Special Studies Zones Act.

The bill would provide that such act is applicable to any development, site, or structure which constitutes a project, upon issuance of the official special studies zone maps to affected local jurisdictions, but that such act does not apply to any such development ~~, site,~~ or structure in existence prior to

the ~~issuance of such maps~~ *effective date of this bill and the act does not apply to the conversion of an existing apartment complex into a condominium nor to alterations or additions to any structure within a special studies zone the value of which does not exceed 50% of the value of the structure*. For purposes of these provisions, the bill would define "project" statutorily, rather than require the State Geologist to make such definition by regulation.

(2) ~~The bill would delete provisions prohibiting city or county approval~~ *Under existing law, cities and counties are prohibited from approving the location* of a development or structure within a special studies zone if an undue *geologic* hazard would be created, ~~authorizing~~ approval *may* ~~to~~ be withheld pending geologic and engineering studies to more adequately define the zone of hazard, and*,* ~~authorizing waiver of such studies~~ if no undue *geologic* hazard is found *the geologic and engineering studies may be waived*. ~~The~~

This bill would, instead, require the city or county to require, prior to the approval of a project, a geologic report defining and delineating any ~~geologic~~ hazard *of surface fault rupture* and authorize waiver of the report requirement if no undue ~~geologic~~ hazard *of this kind* is found.

(3) Under existing law, the State Geologist is required to revise special studies zones or delineate new zones when warranted. Affected cities, counties, and state agencies must submit comments within 30 days for review by the State Mining and Geology Board. Within 30 days of such review, the State Geologist is required to provide copies of revised official maps to concerned state agencies and counties and cities.

This bill would increase the length of both periods from 30 days to 90 days.

(4) The bill would provide that the legal duty of a real estate licensee to disclose the fact that a development, site, or structure is located within a delineated special studies zone is not affected.

(5) The bill would make related, conforming, and clarifying changes, and delete obsolete provisions.

(6) The bill would take effect immediately as an urgency statute.

Vote: ⅔. Appropriation: no. Fiscal committee: yes. State-mandated local program: no state funding.

The people of the State of California do enact as follows:

SECTION 1. *The heading of Chapter 7.5 (commencing with Section 2621) of Division 2 of the Public Resources Code is amended to read:*

CHAPTER 7.5. ~~HAZARD~~ *SPECIAL STUDIES* ZONES

SEC. 2. Section 2621 of the Public Resources Code is amended to read:

2621. This chapter shall be known and may be cited as the Alquist-Priolo ~~Geologic~~ Special Studies Zones Act.

~~SEC. 2~~ *SEC. 3.* Section 2621.5 of the Public Resources Code is amended to read:

2621.5. It is the purpose of this chapter to provide for the adoption and administration of zoning laws, ordinances, rules, and regulations by cities and counties in implementation of the general plan that is in effect in any city or county. The Legislature declares that the provisions of this chapter are intended to provide policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibility to provide for the public safety in hazardous fault zones.

This chapter is applicable to any project, as defined in Section 2621.7, upon issuance of the official special studies zones maps to affected local jurisdictions, but does not apply to any development, ~~site,~~ or structure in existence prior to the ~~issuance of such maps~~ *effective date of the amendment of this section at the 1975–76 Regular Session of the Legislature*.

~~SEC. 3. Section 2621.7~~

SEC. 4. Section 2621.6 is added to the Public Resources Code, to read:

~~2621.7.~~ *2621.6.* *(a)* As used in this chapter, "project" means ~~any new real estate development, or any site for a structure within a new real estate development, subject to the Subdivision Map Act (commencing with Section 66410, Government Code), or any structure for human occupancy, other than a single/family frame dwelling, which is located within a delineated special studies zone.~~

~~SEC. 4~~

(1) Any new real estate development which contemplates the eventual construction of structures for human occupancy, subject to the Subdivision Map Act (commencing with Section 66410 of the Government Code).

(2) Any new real estate development for which a tentative tract map has not yet been approved.

(3) Any structure for human occupancy, other than a single-family frame dwelling not exceeding two stories.

(4) Any single-family frame dwelling not exceeding two stories which is built or located as part of a development of four or more such dwellings constructed by a single person, individual, partnership, corporation, or other organization.

(b) For the purposes of this chapter, a mobilehome whose body width exceeds eight feet shall be considered to be a single-family frame dwelling not exceeding two stories.

SEC. 5. Section 2621.7 is added to the Public Resources Code, to read:

2621.7. This chapter, except Section 2621.9, shall not apply to the conversion of an existing apartment complex into a condominium. This chapter shall apply to projects which are located within a delineated special studies zone.

SEC. 6. Section 2621.8 is added to the Public Resources Code, to read:

2621.8. This chapter shall not apply to alterations or additions to any structure within a special studies zone the value of which does not exceed 50 percent of the value of the structure.

SEC. 7. Section 2621.9 is added to the Public Resources Code, to read:

2621.9. No provision of this chapter shall be construed to affect in any way the duty which a real estate licensee may have under the law to disclose the fact that a development, or structure, including a single-family frame dwelling, is located within a delineated special studies zone.

SEC. 8. Section 2622 of the Public Resources Code is amended to read:

2622. In order to assist cities and counties in their planning, zoning, and building-regulation functions, the State Geologist shall delineate, by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults, and such other faults, or segments thereof, as he deems sufficiently active and well-defined as to constitute a potential hazard to structures from surface faulting or fault creep. Such special studies zones shall ordinarily be one-quarter mile or less in width, except in circumstances which may require the State Geologist to designate a wider zone.

Pursuant to this section, the State Geologist shall compile maps delineating the special studies zones and shall submit such maps to all affected cities, counties, and state agencies, not later than December 31, 1973, for review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within 90 days. Within 90 days of such review, the State Geologist shall provide copies of the official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

The State Geologist shall continually review new geologic and seismic data and shall revise the special studies zones or delineate additional special studies zones when warranted by new information. The State Geologist

shall submit all ~~such revisions~~ *revised maps and additional maps* to all affected cities, counties, and state agencies for their review and comment. Concerned jurisdictions and agencies shall submit all such comments to the State Mining and Geology Board for review and consideration within ~~30~~ *90* days. Within ~~30~~ *90* days of such review, the State Geologist shall provide copies of the revised *and additional* official maps to concerned state agencies and to each city or county having jurisdiction over lands lying within any such zone.

SEC. 9. Section 2623 of the Public Resources Code is amended to read:

2623. The approval of a project by a city or county shall be in accordance with policies and criteria established by the State Mining and Geology Board and the findings of the State Geologist. In the development of such policies and criteria, the State Mining and Geology Board shall seek the comment and advice of affected cities, counties, and state agencies. Cities and counties shall require, prior to the approval of a project, a geologic report defining and delineating any ~~geologic~~ hazard *or surface fault rupture*. If the city or county finds that no undue ~~geologic~~ hazard *of this kind* exists, the geologic report *on such hazard* may be waived, with approval of the State Geologist.

~~SEC. 5~~

After a report has been approved or a waiver granted, subsequent geologic reports shall not be required, provided that new geologic data warranting further investigations is not recorded.

SEC. 10. Section 2625 of the Public Resources Code is amended to read:

2625. (a) Each applicant for approval of a project ~~shall~~ *may* be charged a reasonable fee by the city or county having jurisdiction over the project.

(b) Such fees shall be set in an amount sufficient to meet, but not to exceed, the costs to the city or county of administering and complying with the provisions of this chapter.

(c) The geologic report required by Section 2623 shall be in sufficient detail to meet the criteria and policies established by the State Mining and Geology Board for individual parcels of land.

~~SEC. 6~~ *SEC. 11*. No appropriation is made by this act, nor is any obligation created thereby under Section 2231 of the Revenue and Taxation Code, for the reimbursement of any local agency for any costs that may be incurred by it in carrying on any program or performing any service required to be carried on or

performed by it by this act because any such costs shall be recovered from fees collected pursuant to this act.

~~SEC. 7~~ *SEC. 12.* This act is an urgency statute necessary for the immediate preservation of the public peace, health, or safety within the meaning of Article IV of the Constitution and shall go into immediate effect. The facts constituting such necessity are:

In order to avoid unwarranted delays in real estate development and to relieve homebuilders and owners seeking home improvement of unnecessary financial burdens at the earliest possible time, it is essential that this act take effect immediately.

POLICIES AND CRITERIA OF THE STATE MINING AND GEOLOGY BOARD WITH REFERENCE TO THE ALQUIST-PRIOLO GEOLOGIC HAZARD ZONES ACT (CHAPTER 7.5, DIVISION 2, PUBLIC RESOURCES CODE, STATE OF CALIFORNIA)

(Adopted by State Mining and Geology Board November 21, 1973.)

The legislature has declared in the ALQUIST-PRIOLO GEOLOGIC HAZARD ZONES ACT that the State Geologist and the State Mining and Geology Board are charged under the Act with the responsibility of assisting the Cities, Counties and State agencies in the exercise of their responsibility to provide for the public safety in hazardous fault zones. As designated by the Act, the policies and criteria set forth hereinafter are limited to hazards resulting from surface faulting or fault creep. This limitation does not imply that other geologic hazards are not important and that such other hazards should not be considered in the total evaluation of land safety.

Implementation of the ALQUIST-PRIOLO GEOLOGIC HAZARD ZONES ACT by affected cities and counties fulfills only a portion of the requirement for these counties and cities to prepare seismic safety and safety elements of their general plans, pursuant to Section 65302 (F) and 65302.1 of the Government Code. The special study zones, together with these policies and criteria, should be incorporated into the local seismic safety and safety elements of the general plan.

The State Geologist has compiled and is in the process of compiling maps delineating special studies zones pursuant to Section 2622 of the Public Resources Code. The special studies zones designated on the maps are based on fault data of varied quality. It is expected that the maps will be revised as more complete geological information becomes available. Also, additional special studies zones may be delineated in the future. The Board has certain responsibilities regarding review and consideration of those maps prior to the time that they are finally determined. Cities, Counties and State agencies have certain opportunities under the Act to comment on the preliminary maps provided by the State Geologist and these Policies and Criteria. Certain procedures are suggested herein with regard to those responsibilities and comments.

Please note that the Act is not retroactive. Section 2623 of the Public Resources Code provides that it applies to every proposed new real estate development or structure for human occupancy.

REVIEW OF PRELIMINARY MAPS

The State Mining and Geology Board suggests that each reviewing governmental agency take the following steps in reviewing the preliminary maps submitted for their consideration:

1. All property owners within the preliminary special studies zones mapped by the State Geologist should be notified by the Cities and Counties of the inclusion of their lands within said preliminary special studies zones by publication or other means designed to inform said property owners. Such notification shall not of necessity require notification by service or by mail. This notification will permit affected property owners to present geologic evidence they might have relative to the preliminary maps.

2. Cities and Counties are encouraged to examine the preliminary maps delineating special studies zones and to make recommendations, accompanied by supporting data and discussions, to the State Mining and Geology Board for modification of said zones in accordance with the statute and within the time period specified therein.

3. For purposes of the Act, the State Mining and Geology Board regards faults which have had surface displacement within Holocene time (about the last 11,000 years) as active and hence as constituting a potential hazard. Upon submission of satisfactory geologic evidence that a fault shown within a special studies zone has not had surface displacement within Holocene time, and thus is not deemed active, the Mining and Geology Board may recommend to the State Geologist that the boundaries of the special studies zone be appropriately modified.

The definition of active fault is intended to represent minimum criteria only for all structures. Cities and Counties may wish to impose more restrictive definitions requiring a longer time period of demonstrated absence of displacements for critical structures such as high-rise buildings, hospitals, and schools.

SPECIFIC CRITERIA

The following specific and detailed criteria shall apply within special studies zones and shall be included in any planning program, ordinance, rules and regulations adopted by Cities and Counties pursuant to said GEOLOGIC HAZARD ZONES ACT:

A. No structure for human occupancy shall be permitted to be placed across the trace of an active fault. Furthermore, the area within fifty (50) feet of an active fault shall be assumed to be underlain by active branches of that fault unless and until proven otherwise by an appropriate geologic investigation and submission of a report by a geologist registered in the State of California. This 50-foot standard is intended to represent minimum criteria only for all structures. It is the opinion of the Board that certain essential or critical structures, such as high-rise buildings, hospitals, and schools should be subject to more restrictive criteria at the discretion of cities and counties.

B. Applications for all real estate developments and structures

for human occupancy within special study zones shall be accompanied by a geologic report prepared by a geologist registered in the State of California, and directed to the problem of potential surface fault displacement through the site, unless such studies are waived pursuant to Section 2623.

C. One (1) copy of all such geologic reports shall be filed with the State Geologist by the public body having jurisdiction within thirty days of submission. The State Geologist shall place such reports on open file.

D. Requirements for geologic reports may be satisfied for a single 1 or 2 family residence if, in the judgment of technically qualified City and County personnel, sufficient information regarding the site is available from previous studies in the same area.

E. Technically qualified personnel within or retained by each City or County must evaluate the geologic and engineering reports required herein and advise the body having jurisdiction and authority.

F. Cities and Counties may establish policies and criteria which are more restrictive than those established herein. In particular, the Board believes that comprehensive geologic and engineering studies should be required for any "critical" or "essential" structure as previously defined whether or not it is located within a special studies zone.

G. In accordance with Section 2625 of the Public Resources Code each applicant for a building permit within a delineated special studies zone shall pay to the City or County administering and complying with the ALQUIST-PRIOLO GEOLOGIC HAZARD ZONES ACT a fee of one-tenth of one-percent of the total valuation of the proposed building construction for which the building permit is issued as determined by the local building official.

H. As used herein the following definitions apply:

1. A "structure for human occupancy" is one that is regularly, habitually or primarily occupied by humans.

2. A geologist registered in the State of California is deemed to be technically qualified to evaluate geologic reports.

3. Any engineer registered in the State of California in the appropriate specialty is deemed to be technically qualified to evaluate engineering reports in that specialty.

EXPLANATION OF SPECIAL STUDIES ZONES COMPILED BY THE STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES & GEOLOGY
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

EXPLANATION OF SPECIAL STUDIES ZONES MAPS

COMPILED BY THE STATE GEOLOGIST

Requirements

Maps showing special studies zones were compiled in compliance with Chapter 7.5, Division 2, of the California Public Resources Code. This Chapter, which may be cited as the Alquist-Priolo Geologic Hazards Zones Act, requires the State Geologist to 1) "delineate, by December 31, 1973, appropriately wide special studies zones to encompass all potentially and recently active traces of the San Andreas, Calaveras, Hayward, and San Jacinto Faults ... "and such other faults ..." that "... constitute a potential hazard to structures from surface faulting or fault creep"; and 2) compile maps of special studies zones and submit such maps to affected cities, counties, and state agencies by December 31, 1973, for their review and comment. Following appropriate reviews, the State Geologist must provide "official maps" to the affected cities, counties, and state agencies.

The State Geologist also is required to "continually review new geologic and seismic data" in order to revise the special studies zones or delineate additional zones.

This chapter requires cities and counties to exercise specified approval authority with respect to real estate development or structures for human occupancy within the special studies zones. Specific Policies and Criteria to assist local jurisdictions are provided by the State Mining and Geology Board. Other requirements and guidelines are provided in the Alquist-Priolo Act.

Special Studies Zones

Special studies zones are delineated on topographic base maps at a scale of 1:24,000 (1 inch equals 2000 feet). The zone boundaries are straight-line segments defined by turning points. Each turning point is identified by a number on the map for reference.

The intent of the Alquist-Priolo Act is to provide for public safety from the hazard of fault rupture by avoiding, to the extent possible, the construction of structures for human occupancy astride hazardous faults. The precise location and identification of hazardous faults within or near a zone of potentially active faults can be determined only through detailed geologic investigations. Thus, this Act establishes the concept of a Special Studies Zone -- an area of limited extent centered on recognized faults. Faults other than those depicted on the maps may be present within the Special Studies Zones. The zone boundaries delimit the area that the State Geologist believes warrants special geologic investigations to detect the presence or absence of hazardous faults.

Locations of special studies zone boundaries are controlled by the traces of potentially active faults (defined below), which are based on the best data available at the time the map was compiled. However, the faults shown on the Special Studies Zones maps were not field checked during the compilation of these maps. Because available fault data are highly varied in quality and the locations of some faults are known imprecisely, the zone boundaries have been positioned at a reasonable distance (about 660 feet or an eighth of a mile) from the trace of the nearest potentially active fault. However,

zone boundaries generally are more or less than 660 feet away from mapped faults because of 1) curved or multiple fault traces, 2) of the need to keep the number of turning points to a reasonable minimum, or 3) the quality of the data dictates a narrower or wider zone.

Definitions of Fault Terms

Fault, fault zone

A fault is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. Most faults are the result of repeated displacement which may have taken place suddenly and/or by slow creep. A fault zone is a zone of related faults which commonly are braided and subparallel, but may be branching and divergent. It has significant width (with respect to the scale at which the fault is being considered, portrayed, or investigated), ranging from a few feet to several miles.

Fault trace

A fault trace is the line formed by the intersection of a fault and the earth's surface. It is the representation of a fault as depicted on a map, including maps of the Special Studies Zones.

Potentially active faults

For the purposes of delineating Special Studies Zones, any fault considered to have been active during Quaternary time (last 3,000,000 years)-- on the basis of evidence of surface displacement -- is con-

sidered by the State Geologist to be potentially active. An exception is a Quaternary fault which is determined, from direct evidence, to have become inactive before Holocene time (last 11,000 years). Such a fault is presumed to be essentially inactive and has been omitted from the map in most cases. Although faults shown on the maps may have been active during any part of, or throughout, Quaternary time, evidence for the recency of displacement is incompletely preserved and often is equivocal. In contrast, the State Mining and Geology Board, in their Policies and Criteria (adopted November 21, 1973), has defined any fault which has had surface displacement within Holocene time as "active and hence as constituting a potential hazard."

The surface ruptures associated with historic earthquake and creep events are identified where known. No degree of relative potential for future surface displacement or degree of hazard is implied for the faults shown.

The following geologic time scale is provided for reference and perspective:

GEOLOGIC TIME SCALE
(Abbreviated)

Geologic Age			Years before present (estimated)
Era	Period	Epoch	
CENOZOIC	QUATERNARY	"Historic"	200
		HOLOCENE	11,000
		PLEISTOCENE	2,000,000 – 3,000,000
	TERTIARY	PLIOCENE	7,000,000 – 10,000,000
		pre-PLIOCENE	65,000,000
pre-CENOZOIC time			
Beginning of geologic time			4,600,000,000

Faults defined as active by Policies & Criteria of the State Mining & Geology Board.

Faults defined as potentially active for the purpose of delineating special studies zones.

Uses and Limitations of Special Studies Zones Maps

Users of these maps should be fully aware that the zones are delineated to define those areas within which special studies may be required prior to building structures for human occupancy. Traces of potentially active faults are shown on the maps mainly to justify the locations of zone boundaries. These fault traces are plotted as accurately as the sources of data permit; yet the plots are not sufficiently accurate to be used as the bases for set-back requirements.

The State Geologist has identified potentially active faults in a broad sense, and the evidence for the potential activity of some faults may be only weak or indirect.

The fault information shown on the maps is not sufficient to meet the requirement for special studies. The onus is on the local governmental units to require the developer to evaluate specific sites within the special studies zones to determine if a potential hazard from any fault, whether heretofor recognized or not, exists with regard to proposed structures and their occupants.

ZONING FOR SURFACE FAULT HAZARDS IN CALIFORNIA: THE NEW SPECIAL STUDIES ZONES MAPS

by Earl W. Hart, Geologist, California Division of Mines and Geology

In compliance with the Alquist-Priolo Geologic Hazard Zones Act of 1972, official maps of Special Studies Zones, delineated by the State Geologist, were released 1 July 1974 to the cities and counties affected by the zones. The Special Studies Zones were drawn to encompass potentially hazardous traces of the San Andreas, Calaveras, Hayward, San Jacinto and other faults.

The Alquist-Priolo Act (also known as Chapter 7.5, Division 2 of the California Public Resources Code) provides cities and counties with a means of reducing personal and property damage from fault rupture. The Act applies to all "new real estate developments and structures for human occupancy" within the zones established. Contemplated structures are to be so located as to avoid "undue hazards" that may be created by "surface faulting and fault creep."

The State Geologist, the State Mining and Geology Board, and those cities, counties, and state agencies affected by the Special Studies Zones (table 1) are responsible for the implementation of the Act. The State Mining and Geology Board has the responsibility of providing "policies and criteria" to carry out the law (table 2). Affected cities and counties (table 3) also may impose more restrictive or additional rules and regulations to satisfy their local needs.

The effectiveness of the new legislation will depend on (1) local implementation of ordinances, and (2) geological evaluation of potential surface fault displacement. Given the general guidelines set forth by the State, each city and county affected by the new zones will have to adopt additional special guidelines, or at least make specific interpretations that will enable them to make decisions regarding proposed developments. According to the State Mining and Geology Board, an active fault is defined as one which has had displacement during Holocene time (last 11,000 years) and therefore constitutes a potential hazard. In evaluating a fault with respect to a given proposed development site, the geologist has considerable responsibility. In cases where the existence of a fault hazard is unclear, the local jurisdiction must decide on the basis of the geologic evaluation whether or not the proposed development is an acceptable risk.

Table 1.

Summary of official responsibilities and functions required under the Alquist-Priolo Geologic Hazard Zones Act.

State Geologist (Chief, California Division of Mines and Geology)

1. Delineates Special Studies Zones; compiles and issues maps.
   a. Preliminary Review maps.
   b. Official Maps.
2. Reviews new data.
   a. Revises existing maps.
   b. Compiles new maps.
3. Approves requests for waivers by cities and counties.

State Mining and Geology Board

1. Formulates policies and criteria to guide cities and counties.
2. Serves as Appeal Board for appeals that cannot be coped with locally.
3. Advises State Geologist.

Cities and counties

1. Responsible for local implementation of Act within the delineated Special Studies Zones.
2. Approves permits for development.
3. Collects fees for building and development permits to cover administrative costs.

State agencies

Implied responsibility for siting State structures safely within Special Studies Zones.

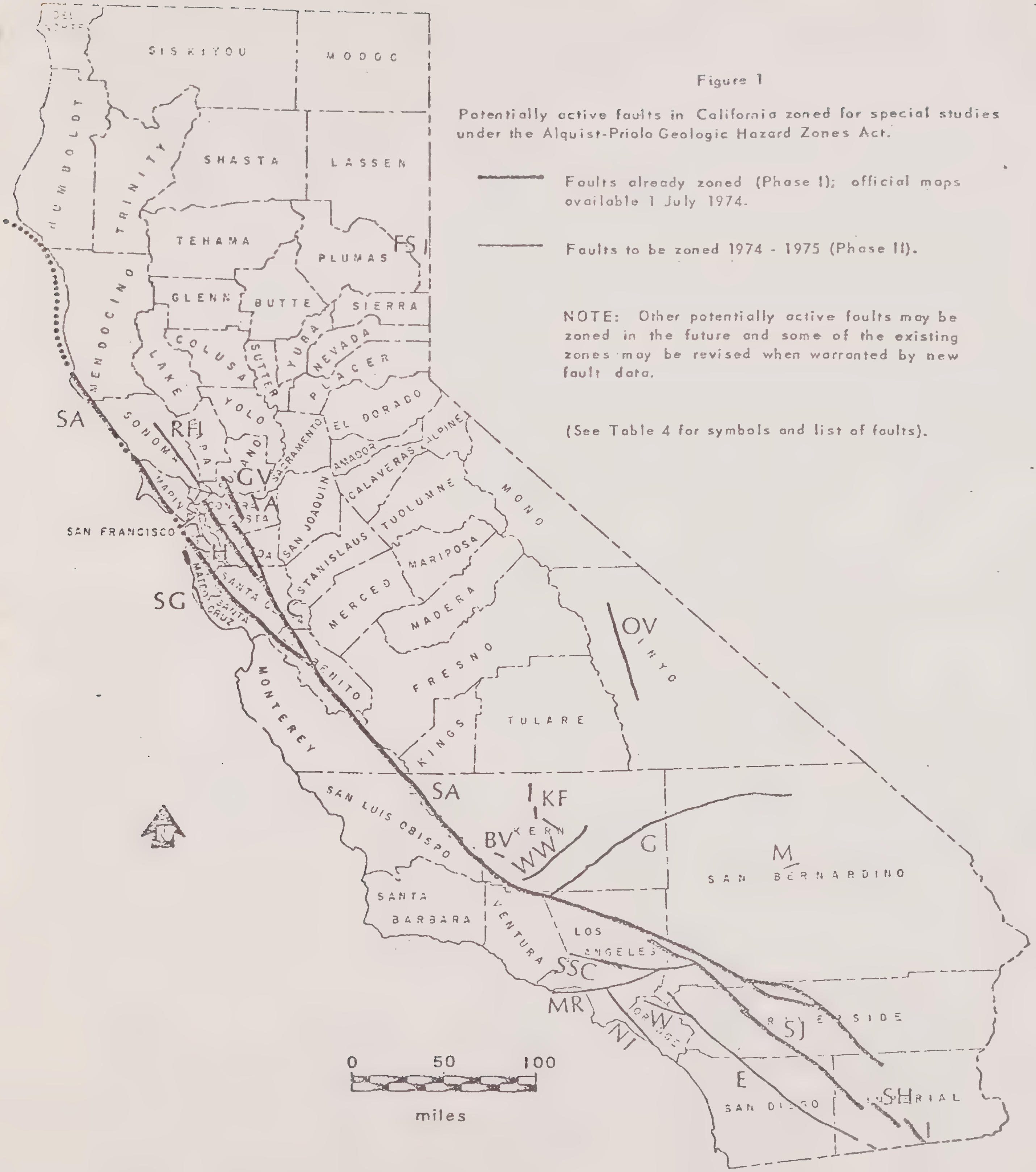


Figure 1

Potentially active faults in California zoned for special studies under the Alquist-Priolo Geologic Hazard Zones Act.

Faults already zoned (Phase I); official maps available 1 July 1974.

Faults to be zoned 1974 - 1975 (Phase II).

NOTE: Other potentially active faults may be zoned in the future and some of the existing zones may be revised when warranted by new fault data.

(See Table 4 for symbols and list of faults).

The CDMG program

Under the Alquist-Priolo Act, the State Geologist (who is also Chief of the State Division of Mines and Geology) is required to delineate the Special Studies Zones and to compile and distribute maps of these zones. A project team, headed by staff geologist Earl Hart, was established within the Division to develop a program for delineation of the zones.

It was determined that the faults named in the Act--the San Andreas, Calaveras, Hayward, San Jacinto--could be zoned by 31 December 1973 with the available funds and staff. The zones were delineated on U. S. Geological Survey topographic maps at a scale of 1 inch equals 2000 feet (1:24,000). This initial phase, whereby Preliminary Review maps were compiled in 1973 and subsequently reviewed and revised for issue as Official Maps on 1 July 1974, is known as Phase I (see map, figure 1; and table 4).

Phase II of the Division program, the delineation of Special Studies Zones for other potentially active faults (table 4), will be accomplished in Fiscal Year 1974-1975 and the Preliminary Review maps issued around mid-1975. Following the prescribed review and revision periods of 90 days each, Offcial Maps will be issued at the end of 1975. At that time, any newly established or revised zoning will become effective and the affected cities and counties will be required to implement the Act within the zoned areas.

Table 2.

Summary of policies and criteria adopted by the State Mining and Geology Board, effective 1 July 1974

Policies

1. Specifies that the Act is not retroactive.
2. Suggests methods relating to review of Preliminary Maps prior to issuance of Official Maps.
3. Policies and criteria apply only to area within the Special Studies Zones.
4. Defines *active fault* (aquals potential hazard) as a fault that has had surface displacement during Holocene time (last 11,000 years).

Specific criteria

1. No structures for human occupancy are permitted on the trace of an active fault. (Unless proven otherwise, the area within 50 feet of an active fault is presumed to be underlain by an active fault).
2. Requires geologic report directed at the problem of potential surface faulting for all real estate developments and structures for human occupancy.
3. Requires that geologic reports be placed on open file by the State Geologist.
4. Requires cities and counties to review adequacy of geologic reports submitted with requests for development permits.
5. Permits cities and counties to establish standards more restrictive than the policies and criteria.
6. Sets fees for building permits at 0.1 percent of estimated assessed valuation of proposed structure.
7. Defines a) structure for human occupancy, b) technically qualified geologist, and c) new real estate development.

Although there are many other potentially active faults in California that could be zoned, the faults listed under Phase II in table 4 include (1) all of the known historically active faults not zoned under Phase I, and (2) major potentially active faults, especially those situated in areas of

Table 3.

Cities and counties affected by Special Studies Zones

Incorporated cities

Banning	El Cerrito	Martinez	Pleasanton	San Juan Bautista
Benicia	Fairfield	Millbrae	Portola Valley	San Leandro
Berkeley	Fremont	Milpitas	Redlands	San Pablo
Burlingame	Hayward	Morgan Hill	Redwood City	South San Francisco
Coachella	Hemet	Oakland	Rialto	Union City
Colton	Hercules	Pacifica	Richmond	Walnut Creek
Concord	Hollister	Palmdale	San Bernardino	Woodside
Daly City	Indio	Palo Alto	San Bruno	
Desert Hot Springs	Loma Linda	Pinole	San Jose	

Counties

Alameda	Kern	Monterey	San Diego	Santa Cruz
Contra Costa	Los Angeles	Riverside	San Luis Obispo	Solano
Humboldt	Marin	San Benito	San Mateo	Sonoma
Imperial	Mendocino	San Bernardino	Santa Clara	Ventura

current development. The zoning of faults in Phase II will be done on a priority basis according to the manpower and funds available, and existing data.

In the meantime, the State Geologist will continue to review new information and revise existing Special Studies Zones as necessary. It is planned that copies of all geologic reports submitted to the cities and counties for the purpose of obtaining permits for development will be kept on open file at the Division's San Francisco office in Room 1016, Ferry Building.

Table 4.

Faults to be zoned for special studies (on priority basis), under Alquist-Priolo Act; CDMG program through 1975. See figure 1 for location of faults.

Fault	*Map symbol*
Phase I (zoning complete):	
Calaveras	C
(includes Green Valley and Concord)	GV
Hayward	H
San Andreas	SA
San Jacinto	SJ
(includes: Imperial	I
Superstition Hills)	SH
Phase II (1974-1975):	
Antioch	A
Buena Vista	BV
Elsinore-Chino	E
Fort Sage	FS
Garlock	G
Kern Front	KF
Manix	M
Malibu Coast-Raymond	MR
Newport-Inglewood	NI
Owens Valley	OV
Rogers Creek-Healdsburg	RH
San Gregorio	SG
Sierra Madre-Santa Susana-Cucamonga (includes "San Fernando")	SSC
Whittier	W
White Wolf	WW

Available information

For those readers interested in obtaining more detailed information on the Alquist-Priolo Act and the Division's program, the following references are available:

1. *Index to maps of Special Studies Zones* (containing supplementary text of the Alquist-Priolo Act, Policies and Criteria of the State Mining and Geology Board, and a list of cities and counties affected by the Special Studies Zones), California Division of Mines and Geology Special Publication 42. Price: $1.00, plus tax.

2. *Maps of Special Studies Zones* (see Index map). Full scale maps (1 inch equals 2000 feet) may be consulted at offices of the cities and counties affected by the zones (table 3) or at any district office of the California Division of Mines and Geology. Individual copies may be obtained from many local jurisdictions or they may be purchased commercially from Blue Print Service Company, 149 Second Street, San Francisco 94105 (attention: Ellen Schermerhorn; phone: 415-495-8700).

3. Explanation of Special Studies Zones Maps. Free.

4. *Guidelines to geologic and seismic reports.* CDMG Note 37. Free.

5. *Model ordinance for cities and counties to implement the Alquist-Priolo Act.* This is an informal set of regulations for quidance purposes only. Price: $0.25.

Items 1, 3, 4, and 5 can be obtained at CDMG district offices or by mail from California Division of Mines and Geology, P. O. Box 2980, Sacramento, California 95812. ⚒

MINERAL AND ENERGY CONFERENCE

The Pacific Southwest Mineral and Energy Conference will be held 11, 12, and 13 November 1974 at the Hilton Hotel, Los Angeles, California. The American Institute of Mining, Metallurgical and Petroleum Engineers, and the Western Oil and Gas Association, join the U.S. Bureau of Land Management and the California Mine Operators Association in sponsoring the event.

The program will be geared principally to energy minerals, covering geology, mining, environmental considerations and management. Speakers are nationally recognized authorities in their field from top management in industry and government. This biennial conference will provide government and industry with a meeting ground for the exchange of ideas and information regarding mineral production and management.

For further information contact: G. W. Nielsen, U.S. Bureau of Land Management, 2800 Cottage Way, Room E-2841, Sacramento, California 95825. ⚒

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